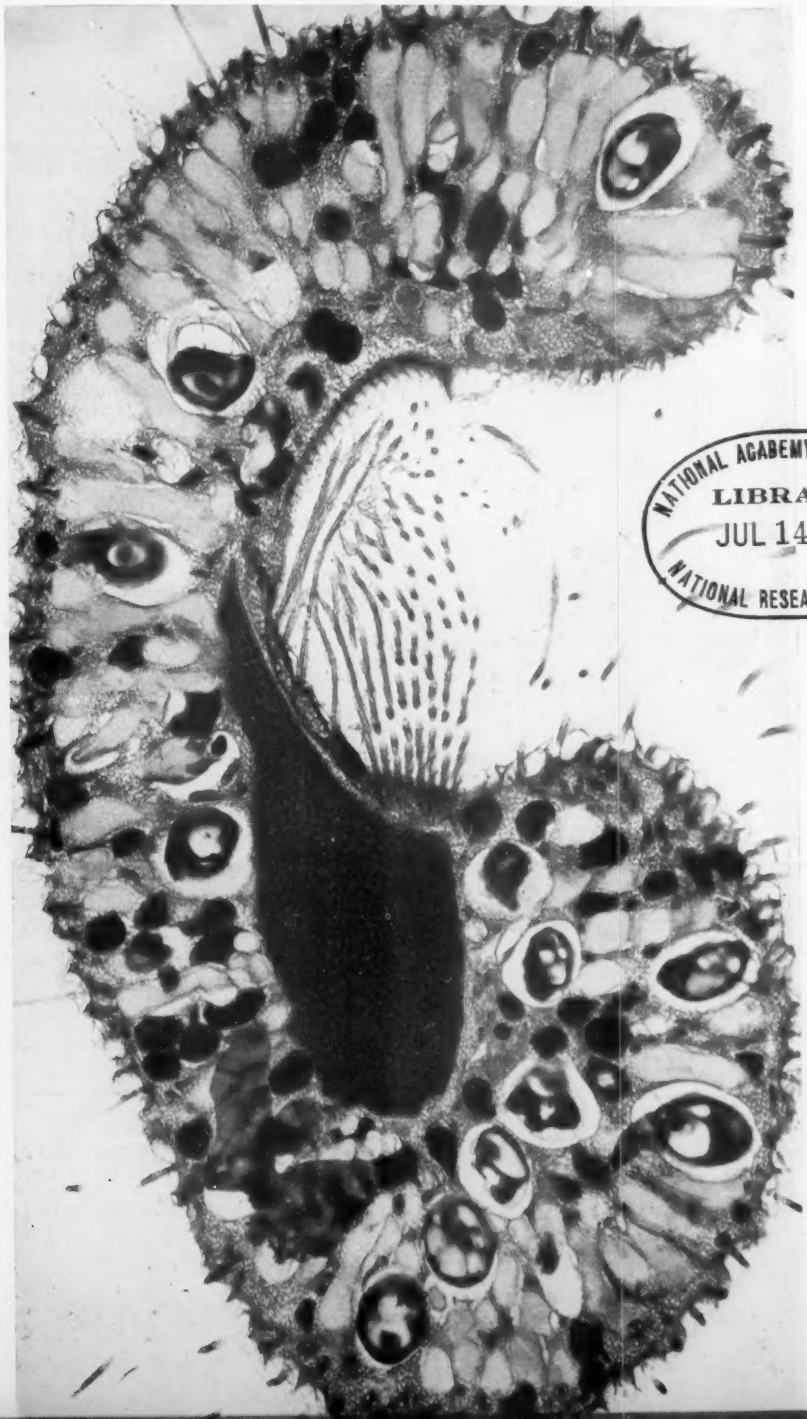
SCIENCE

15 July 1960
Vol. 132, No. 3420

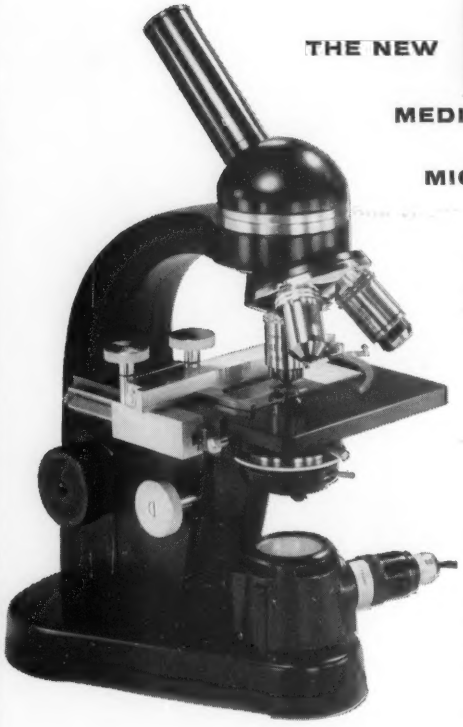
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



NATIONAL ACADEMY OF SCIENCES
LIBRARY
JUL 14 1960
NATIONAL RESEARCH COUNCIL

THE NEW Leitz

MEDICAL & LABORATORY MICROSCOPE **SM**



A TYPICAL COMBINATION OF ACCESSORIES
MEDICAL & LABORATORY MICROSCOPE **SM,** with inclined monocular tube, mechanical stage; two-lens condenser with swing-out upper element and iris diaphragm; quadruple nosepiece; substage illuminator; carrying case. With optical outfit consisting of achromats 3.5x, 10x, 45x, and 100x—oil 6x and 10x eyepieces.

Leitz sets a new standard in introducing this general purpose microscope for student and laboratory use. The **SM** model embodies the advances of design and craftsmanship that only 100 years of microscope experience can provide. It combines solid construction and operational ease with true accuracy and precision. The Leitz MEDICAL & LABORATORY MICROSCOPE **SM** is the ideal microscope for the laboratory. Among its outstanding features are:

- Famous Leitz ball-bearing, single knob, dual focusing control, combines fine and coarse focusing
- Handsome design, solid and dependable construction
- Flat-surfaced stand of corrosion-resistant light alloy
- May be used turned away from observer for easy accessibility to slide
- Instant-locking device changes tubes (inclined or straight monocular or binocular) in a one-step operation
- Variety of object stages to choose from
- Removable mirror interchanges with attachable illuminators
- Retractable spring-loaded mounts on high-powered objectives provide positive protection against damage to slide or front lens.

E. Leitz, Inc., Dept. Sc-715
468 Park Ave., South, New York 16, N. Y.

Please send me additional information on the **SM** Microscope

NAME_____

STREET_____

CITY_____ ZONE_____ STATE_____

21357

E. LEITZ, INC., 468 PARK AVENUE SOUTH, NEW YORK 16, N. Y.
Distributors of the world-famous products of
Ernst Leitz G. m. b. H., Wetzlar, Germany—Ernst Leitz Canada Ltd.
LEICA CAMERAS · LENSES · PROJECTORS · MICROSCOPES · BINOCULARS

prompt delivery of Carbon^{14} and Tritium labeled compounds

Your local Picker office (see 'phone book) is a dependable source for any or all of the 200-odd compounds classified below. In this, as in all other matters having to do with nuclear equipment and/or supplies, your local Picker man stands ready to serve you promptly and efficiently.

Carbon^{14} labeled compounds

- Simple Carbon Compounds
- Acetylene and Ethylene Derivatives
- Alcohols and Their Derivatives
- Acids and Their Derivatives
- Amino Acids
- Benzene Ring Labeled Compounds
- Amines and Their Derivatives
- Saturated Hydrocarbons
- Uniformly Labeled Carbohydrates

Tritium labeled compounds

- Specifically labeled Tritium compounds
- Tritium compounds labeled by the Wilzbach technique

All these compounds may be obtained in standard millicurie or fractional millicurie packages and many of them are also available in 50 microcurie license-exempt packages.

PICKER nuclear instruments

speaking of equipment,

SCALERS

PULSE HEIGHT ANALYZER

WELL TYPE SCINTILLATION DETECTOR

PROPORTIONAL FLOW COUNTER

AUTOMATIC SAMPLE CHANGER

AUTOMATIC WELL COUNTER

PRECISION RATEMETER

RADIOASSAY DETECTORS AND ACCESSORIES

LABORATORY MONITOR

Picker nuclear

which of these informative brochures may we send you?

Simply check those wanted—and mail to Picker X-Ray Corp., 25 So. Broadway, White Plains, N.Y.

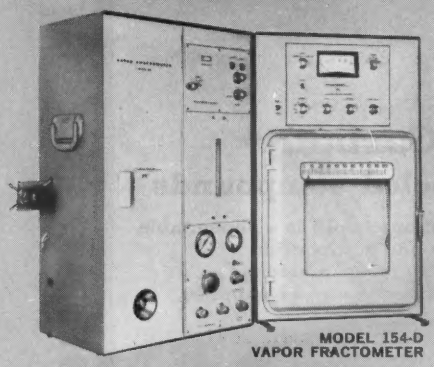
Name _____

Address _____

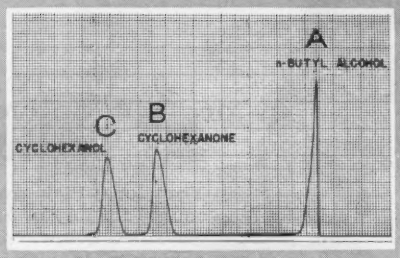
City _____ State _____

SCIENCE is published weekly by the AAAS, 1515 Massachusetts Ave., NW, Washington 5, D.C. Second-class postage paid at Washington, D.C., and additional mailing office. Annual subscriptions: $8.50; foreign postage, $1.50; Canadian postage, 75¢.

UNKNOWN MIXTURE



MODEL 154-D
VAPOR FRACTOMETER

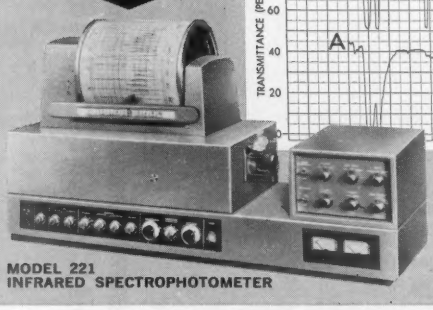


SEPARATION BY VAPOR FRACTOMETER: Fractogram shows quantities of individual components in unknown mixture separated and collected, but as yet unidentified.

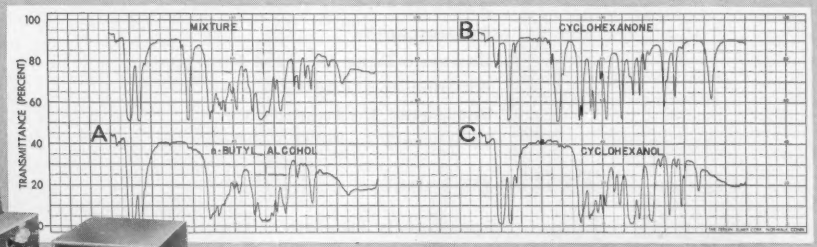
component A

component B

component C



MODEL 221
INFRARED SPECTROPHOTOMETER



IDENTIFICATION BY IR: Collected components run in standard microcell on Model 221, using scale compression to include entire analysis on single chart, are identified as A, n-butyl alcohol; B, cyclohexanone; C, cyclohexanol. IR run of mixture is not essential, but may be valuable to analyst in some cases.

HOW GAS CHROMATOGRAPHY AND INFRARED TEAM UP TO ANALYZE DIFFICULT MIXTURES FAST... ACCURATELY

Extend your analytical capabilities by teaming up Perkin-Elmer gas chromatography and Perkin-Elmer infrared spectroscopy to take advantage of the special features of each. This combination gives you greater speed and accuracy—both qualitative and quantitative—than either technique alone, in analyzing such mixtures as close boilers, isomers and similar hard-to-separate compounds.

In practice, an unknown mixture is separated into pure fractions by a P-E Model 154-D Vapor Fractometer as it records a fractogram, giving quantitative peaks for the separated components. The individual components, cold-trapped or collected in a solvent as they elute from the instrument, are then run in an infrared spectrophotometer such as the Perkin-Elmer Model 221. The IR spectrum of each of the collected samples provides positive qualitative and quantitative identification.

Both the Model 154-D and the grating Model 221 are the most advanced instruments of their type, each offering unusual versatility, speed and accuracy. And special P-E accessories further enhance their usefulness. For example, capillary columns (U.S. Patent No. 2,920,487) and ionization detectors for gas chromatography, plus accessory beam condensers for IR examination of micro-samples, allow analyses of small samples beyond the scope of conventional equipment.

For complete information on these new P-E instruments, and how they team up to form an even more powerful analytical system, write to us today.

INSTRUMENT DIVISION
Perkin-Elmer *Corporation*
NORWALK, CONNECTICUT

15 July 1960, Volume 132, Number 3420

SCIENCE

Editorial Shades of the Sacred Grove 113

Articles Organelle Systems and Biological Organization: *C. F. Ehret* 115

Structural and developmental evidence leads to a new look at our concepts of biological organization.

Trends in Polarography: *J. Heyrovsky* 123

Science in the News "Health for Peace" Bill Passed; AAAS-Westinghouse Science Writing Competition Announced; AAAS Theobald Smith Award 131

Book Reviews *The American Voter*, reviewed by *P. H. Odegard*; other reviews 138

Reports Marine Planation of Tropical Limestone Islands: *N. D. Newell* 144

Y-Chromosome Inheritance of Hairy Ears: *R. R. Gates* 145

Locomotor Activity of Land Crabs during the Premolt Period: *D. E. Bliss* 145

Late Tertiary Microflora from the Basin and Range Province, Arizona: *J. Gray* 147

Avian Uptake of Fission Products from an Area Contaminated by Low-Level Atomic Wastes: *W. K. Willard* 148

Antiozonants To Protect Plants from Ozone Damage: *S. Rich* and *G. S. Taylor* 150

Serial Lactic Dehydrogenase Activity in Plasma of Mice with Growing or Regressing Tumors: *V. Riley* and *F. Wroblewski* 151

Communicative Mandible-Snapping in Acrididae (Orthoptera): *R. D. Alexander* 152

Dialysis of Certain Sugars through Cellophane: *M. B. Templeman* and *L. M. Marshall* .. 153

Contribution of Hardtack Debris to Contamination of the Air during 1959: *L. B. Lockhart, Jr.*, et al. 154

Departments Letters from *J. B. Sykes; J. H. Steward* and *A. Leeds; W. F. Longgood* and *W. J. Darby* 110

Preserving Our Science Archives; Forthcoming Events 158

Cover A cross section through the gullet region of the ciliated protozoan *Paramecium bursaria*. The round dark objects are the symbiotic alga *Chlorella*. The numerous clear ellipsoids below the surface are the trichocyst bodies, and the irregularly shaped dark body near the center is the macronucleus. The food-intake passage is lined by about 1000 cilia arranged in 12 columns. The row of 12 shown in the picture is composed of three groupings, with four cilia to each group spaced 0.46 microns apart on centers. See page 115. [Photograph by L. E. Roth, Argonne National Laboratory, Lemont, Ill., from C. F. Ehret and E. L. Powers, "The cell surface of *Paramecium*," *Intern. Rev. Cytol.* **8**, 97 (1959)].

FOR
laboratory
recording

OFFNER
TYPE 542
DYNOGRAPH

A new high-speed, sensitive, stable, two-channel direct writing oscillograph, ideal for laboratory use.

The OFFNER Type 542 Dynograph provides *sensitivity*—one MV d-c per mm; *stability*—with instant warm-up; *rapid response*—1.5 millisecond deflection time, —and large, easily read records—5 cm deflection with one percent linearity. Records everything from mechanical vibrations in the engineering lab to action potentials for the neurophysiologist.

Write for complete details.

OFFNER
TYPE R
DYNOGRAPH

When your research demands the ultimate in direct writing recorders, investigate the Offner Type R. Available in a variety of standard and special assemblies.

OFFNER ELECTRONICS INC.
3950 River Road, Schiller Park, Ill.
(Suburb of Chicago)

Letters

Abbreviated Reference Citations

May I make a plea for considerably more sparing use of abbreviations when citing references to scientific periodicals? I believe this practice originated at a time when periodicals were far fewer in number, and when references were commonly placed in footnotes, its purpose being presumably to prevent the footnotes' occupying too much space.

Nowadays, few are familiar with the titles of the majority of periodicals, and references are usually listed at the end of each article. The amount of space saved by abbreviation of titles is negligible, and the obscurity thereby introduced may well be considerable for some readers, especially when such heights of esotericism are reached as *B.A.N.* for *Bulletin of the Astronomical Institutes of the Netherlands* or *Röfo* for *Fortschritte auf dem Gebiete der Röntgenstrahlen*. Sometimes, as in abstract journals, where condensation is of great importance, the practice of abbreviating titles may be tolerated, but for the most part it gains nothing and merely sets the reader a more or less difficult conundrum whenever he wishes to trace a reference so cited.

J. B. SYKES
46 NorthCourt Road, Abingdon, Berkshire, England

Native Peoples of South America

Leeds' review of *Native Peoples of South America* [*Science* **131**, 94 (8 Jan. 1960)] calls for comment regarding responsible reviewing rather than reply to particular points.

First, I must mention that what are absurdly called "unnecessary errors" refer mostly to works published after the manuscript was in press and to works *not yet published*. For example, Leeds knows that his own research among the Yaruro had not yet been started in December 1957, when I worked on a final revision of the manuscript, for at that time he asked me for advice regarding where to work in the field. I received Moore's study of Inca property and law for review about the time *Native Peoples* was published. Murra's work on the Inca is, so far as I know, still unpublished.

An author is obligated, of course, to keep reasonably abreast of the published literature. At the same time, it is rather pointless for the reviewer to carp about omission of published and unpublished research done after the book was written. If the reviewer believes that the research makes an important difference in scientific understanding, rather than in descriptive minutiae, he should spell out his point, preferably in an article of his own or in "Notes and Comments."

Second, Leeds seems not to have read the book carefully, for he makes the incredible assertion that it merely follows the culture area divisions of the *Handbook of South American Indians* [(Bureau of American Ethnology, 1948), vols. 1–6], which I edited. The *Handbook* is based upon four culture areas; *Native Peoples*, upon eight cultural types and 11 subtypes, which correspond only partly to areas. The book explains repeatedly that this typology is evolutionary in being based upon structure and developmental process rather than upon the traditional descriptive and historical taxonomy used in the *Handbook*.

While anthropologists will not be misled by the carelessness of this review, the general reader might conclude that *Native Peoples* has little new to offer.

JULIAN H. STEWARD
University of Illinois, Urbana

Steward's reaction surprised me, as I still feel my review was favorable. I pointed out that the book constitutes a "useful compendium . . . for professionals and students alike," and has originality respecting historical reconstructions from linguistic affiliations, American Indian acculturation, and trans-Pacific diffusion. Further, the review listed all eight culture types Steward mentions.

However, to me, responsible book reviewing, as Steward's own reviews suggest [for example, *Am. Anthropologist* **62**, 144 (1960)], means more than mere repetition of contents. The reviewer must make a critique according to his view of the truth. Hence, I called the present classification a "refinement" of the *Handbook* classification because I felt it was already largely suggested there. Hence, too, I made criticisms of two kinds. The first concerned explanatory principles. Similar phenomena suggest using common explanatory principles. If common principles are inapplicable, this, too, must be shown. I felt the authors failed to do either regarding warfare, for example, thus possibly missing aboriginal evolutionary regularities. The second concerned the "unnecessary errors" which referred to *facts*, for which I gave sources, all published in, or before, 1957, 2 years before the book's publication, including one on the Yaruro [Le Besnerais, *J. soc. américanistes* (1954)]. "Unnecessary" implies that *standard* interpretations of data exist. Unless these are reinterpreted with relevant rationales and new data, as was

(Continued on page 156)

The New SARGENT Model XV
RECORDING POLAROGRAPH®

offers you—

- **FULL 10 INCH CHART**
- **1/10% ACCURACY OF MEASUREMENT**
- **TEN STANDARDIZED POLARIZING RANGES**

This new Sargent Polarograph gives you a large 250 mm (10 inches) chart and the highest accuracy and current sensitivity at the lowest price of any pen writing polarographic instrument on the market.

It offers you optimum specifications based on over twenty years of leadership in design, manufacture and service in this specialized field of analysis.

The polarographic method is capable of reproducibility to 1/10% and analytical accuracy to ½%. To make use of this facility, the instrument must be accurate to 1/10% and chart space must be provided for recording large steps to achieve measuring precision. We strongly advise against the purchase of any polarographic instrument using miniature (5 inch) charts and low gain balancing systems in the 1% order of precision.

This Model XV is adaptable to 10^{-8} M determinations with the S-29315 Micro Range Extender.

®Registered Trade Mark, Patents Pending

Current Ranges:	19, from .003 to 1.0 μA/mm.
Current Sensitivity:	standard specifications, 10^{-4}μA/mm.
Polarizing Ranges, volts:	0 to −1; −1 to −2; −2 to −3; −3 to −4; +.5 to −5; 0 to −2; −2 to −4; +1 to −1; 0 to −3; +1.5 to −1.5.
Balancing Speed:	standard, 10 seconds; 1 second or 4 seconds optional.
Bridge Drive:	synchronous, continuous repeating, reversible; rotation time, 10 minutes.
Chart Scale:	current axis, 250 mm; voltage axis, 10 inches equals one bridge revolution.
Current Accuracy:	1/10%
Voltage Accuracy:	¼%
Chart Drive:	synchronous, 1 inch per minute standard; other speeds optional.
Writing Plate:	10½ x 12½ inches; angle of slope, 30°.
Standardization:	manual against internal cadmium sulfate standard cell for both current and voltage.
Damping:	RC, four stage.
Pen:	ball point; Leroy type optional.
Suppression:	zero displacement control, mercury cell powered, 6 times chart width, upscale or downscale.
Potentiometric Range:	2.5 millivolts, usable as general potentiometric recorder.
Finish:	case, enameled steel; panels, anodized aluminum; writing plate, polished stainless steel; knobs and dials, chromium plated and buffed.
Dimensions:	23 x 17 x 10.
Net Weight:	65 pounds.

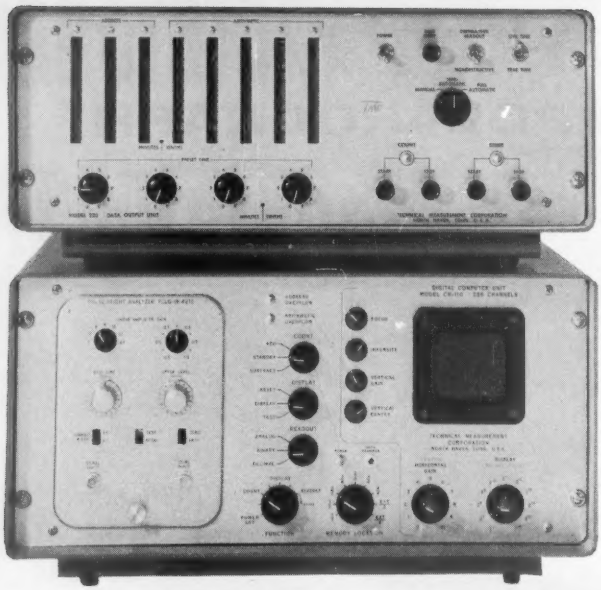
Catalog number **S-29310** with accessories and supplies. . . . **$1585.00**

For complete information write for Sargent Bulletin P

SARGENT *SCIENTIFIC LABORATORY INSTRUMENTS • APPARATUS • SUPPLIES • CHEMICALS*

E. H. SARGENT & CO., 4647 W. FOSTER, CHICAGO 30, ILLINOIS
DETROIT 4, MICH. • DALLAS 35, TEXAS • BIRMINGHAM 4, ALA. • SPRINGFIELD, N.J.

256 THE TMC 256-CHANNEL PULSE ANALYSIS SYSTEM

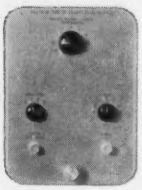


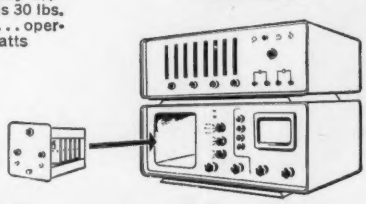
#220 DATA HANDLING UNIT usable as an active timer, event counter and readout device ... effective or actual counting times may be selected from 0.1 to 999.9 minutes in 0.1 min. steps ... manual, semi- or fully automatic operation, destructive and non-destructive readout.

PULSE HEIGHT ANALYSIS – #210 plug-in ... built-in linear amplifier, pulse generator ... 10-74 μs. dead time ... ±0.5% linearity

The Model CN-110 digital computer assembly ... only 8¾" high ... weighs 30 lbs. with plug-in ... operates on 25 watts

TIME-OF-FLIGHT MEASUREMENT #211 plug-in ... built-in delay of 0,1,2,3 times address cycle ... choice of 9 channel lengths from 0.25 to 64 μs. ... automatic channel advance

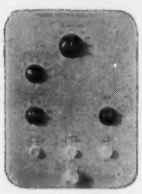




ONE BENCH-TOP INSTRUMENT...

Becomes a different pulse analyzer every time you change the logic

PULSED NEUTRON MEASUREMENT – #212 plug-in ... analysis channel lengths from 10 to 2560 μs. ... 10 μs. storage time ... (a high speed arithmetic scaler is supplied with the CN-110 at no extra charge when the 212 unit is purchased with it)



With just one CN-110 in your laboratory you have 256 channels of the pulse analysis you need – whether it's pulse height, time-of-flight, pulsed neutron or a special program. When you plug in the logic network, the instrument becomes a ready-to-use analysis system for that program. And you can change them in the time it takes to loosen a thumbscrew. Total weight is only 30 lbs., all circuits are transistorized – making this today's most versatile, compact pulse analyzer for research, field work or regular laboratory use. *They are now in production and deliveries are being made.*

THE BASIC UNIT IS A COMPLETE DIGITAL COMPUTER with all the circuitry for a 256-channel magnetic core memory and has the advantages of completely enclosed, plug-in memory ... choice of memory sub-groups ... pushbutton data transfer ... instantly selected analog, binary or digital readout.

FOR DATA HANDLING, a readout instrument has been designed specifically for use with the CN-110. The compact #220 data handling unit can be used as a live-timer during data gathering and as a readout system afterward. The #220 can be used with various types of paper tape printing and punching instruments.

Other readout devices that you can use with the CN-110 include strip chart and X-Y recorders, magnetic computer tape, punched paper cards.

Write for the new 6-page bulletin which contains complete details of the CN-110 and all accessories.

TECHNICAL MEASUREMENT CORPORATION TMC **441 WASHINGTON AVE., NORTH HAVEN, CONN.**

15 July 1960, Volume 132, Number 3420

SCIENCE

AMERICAN ASSOCIATION
FOR THE
ADVANCEMENT OF SCIENCE

Board of Directors

CHAUNCEY D. LEAKE, *President*
THOMAS PARK, *President Elect*
PAUL E. KLOPSTEG, *Retiring President*
HARRISON BROWN
H. BENTLEY GLASS
MARGARET MEAD
DON K. PRICE
MINA REES
ALFRED S. ROMER
WILLIAM W. RUBEY
ALAN T. WATERMAN
PAUL A. SCHERER, *Treasurer*
DAEL WOLFLE, *Executive Officer*

Editorial Board

KONRAD B. KRAUSKOPF H. BURR STEINBACH
EDWIN M. LERNER WILLIAM L. STRAUS, JR.
EDWARD L. TATUM

Editorial Staff

DAEL WOLFLE, *Executive Officer*
GRAHAM DUSHANE, *Editor*
JOSEPH TURNER, *Assistant Editor*
ROBERT V. ORMES, *Assistant Editor*

CHARLOTTE F. CHAMBERS, SARAH S. DEES, NANCY S. HAMILTON, OLIVER W. HEATWOLE, YUKIE KOZAI, HOWARD MARGOLIS, ELLEN E. MURPHY, ELEANOR D. O'HARA, BETHSABE PEDERSEN, NANCY L. TEIMOURIAN, DAVID A. TEMELES, LOIS W. WOODWORTH

EARL J. SCHERAGO, *Advertising Representative*

SCIENCE, which is now combined with THE SCIENTIFIC MONTHLY, is published each Friday by the American Association for the Advancement of Science at National Publishing Company, Washington, D.C. The joint journal is published in the SCIENCE format. SCIENCE is indexed in the *Reader's Guide to Periodical Literature*.

Editorial and personnel-placement correspondence should be addressed to SCIENCE, 1515 Massachusetts Ave., NW, Washington 5, D.C. Manuscripts should be typed with double spacing and submitted in duplicate. The AAAS assumes no responsibility for the safety of manuscripts or for the opinions expressed by contributors. For detailed suggestions on the preparation of manuscripts and illustrations, see *Science* **125**, 16 (4 Jan. 1957).

Display-advertising correspondence should be addressed to SCIENCE, Room 740, 11 West 42 St., New York 36, N.Y.

Change of address notification should be sent to 1515 Massachusetts Ave., NW, Washington 5, D.C., 4 weeks in advance. If possible, furnish an address label from a recent issue. Give both old and new addresses, including zone numbers, if any.

Annual subscriptions: $8.50; foreign postage, $1.50; Canadian postage, 75¢. Single copies, 35¢. Cable address: Advancesci, Washington.

Copyright 1960 by the American Association for the Advancement of Science.

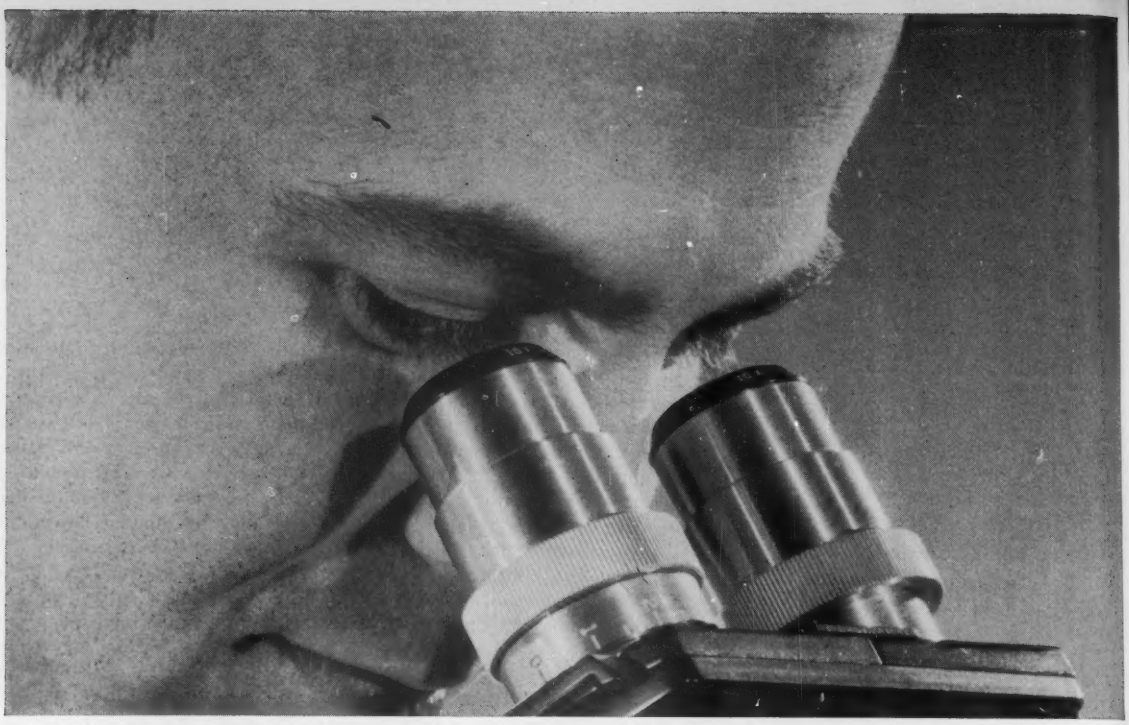
Shades of the Sacred Grove

The animistic habit of thought, which attributes human purposes and characteristics to nonsentient organisms such as living plants, is widely followed by primitive man. The trees of the sacred groves of ancient Europe were thought to have souls and to be sensitive to pain; severe penalties were imposed on anyone who cut off a branch or injured the bark of a sacred tree; propitiatory rites were often enacted to gain a tree's forgiveness if it became necessary to fell it. Similar views were also commonly held about nonliving things. Darwin, in his account of the voyage of H.M.S. *Beagle*, tells of an amusing incident that illustrates the distinction between a scientific and an animistic explanation of an event. When he and his guides were camping at an elevation of about 11,000 feet in the Chilean Andes, they attempted to cook potatoes by boiling. Even boiling overnight was unsuccessful. The scientific explanation was, as Darwin knew and pointed out to his readers if not to his uneducated guides, simply that water boils at low temperature at high altitudes. The guides had another explanation, which was "that the cursed pot (which was a new one) did not choose to boil potatoes."

Animism, prescientific though it is, is still with us. The gambler entertains animistic thoughts about dice and slot machines, and the gardener may say that azaleas "prefer" an acid soil. Such informal and private views may be excused if not condoned. It is harder to excuse, much less condone, the publication of animistic interpretations in the press.

A notable instance of such publication is in the article "Revolution Rocks the Plant Kingdom!" which appeared in the 26 June issue of *This Week* magazine. Here is animism at its worst. Plants are said to be "a good deal more sensitive than anyone ever suspected," and when "injured they try to get revenge by spreading their own brand of poison." L. Ron Hubbard, the promoter of "dianetics," who is described as an American scientist, is quoted as saying that plants can feel pain and worry. According to the article, Hubbard has been applying a skin galvanometer to tomatoes, "like the one used on humans to detect emotional changes such as fear and guilt. When a nail is stuck into a tomato, the indicator on the galvanometer dial quivers and begins to fall." The reports of others, some of them scientists of good repute, are twisted to fit into the animistic framework: plants can be "confused" by being grown upside down or "bamboozled into believing" that winter is approaching if they are shaded for part of the day. Putting citrus plants "to sleep" with tranquilizers is said to help them resist frost.

This is irresponsible journalism. It presents a false view of nature and a false view of science. It fails to distinguish the work of genuine scientists from that of quacks. The remedy is obvious. No editor would assign a tone-deaf writer to review a concert or a person with no special knowledge of the theater to review plays. Science demands no less. Several hundred professional science writers with high standards, a sharp eye for chicanery, and a professional organization—the National Association of Science Writers—are available. Why not make more use of them?—G.DuS.



See the *Dynoptic* difference

B&L DYNOPTIC DESIGN

saves time . . . You get today's fastest focus. And you *keep* it . . . no drift, no backlash. From automatic focus to parfocal objectives, B&L gives you more minutes per hour.

saves effort . . . Your hands rest on table for orientation and fine adjustment. Focusing system "floats" on rollers and bearings for the easiest operation you've ever known.

saves your eyes . . . Wide, flat, clear fields make it easier to interpret complex specimens. You can get ample light for deeply stained specimens, for phase contrast or dark field work. See for yourself in a demonstration at your convenience.

MAIL COUPON FOR DATA AND DEMONSTRATION

BAUSCH & LOMB
SINCE B&L 1853

BAUSCH & LOMB
Dynoptic
MICROSCOPES
LABORATORY • RESEARCH • POLARIZING • METALLURGICAL

BAUSCH & LOMB INCORPORATED
75907 Bausch St., Rochester 2, N. Y.

I would like ☐ data and ☐ demonstration of the following B&L Dynoptic Microscopes:

☐ Laboratory ☐ Research
☐ Polarizing ☐ Metallurgical

NAME, TITLE .....

PROFESSIONAL ADDRESS .....

.....

.....

15 July 1960, Volume 132, Number 3420 SCIENCE

CURRENT PROBLEMS IN RESEARCH

Organelle Systems and Biological Organization

Structural and developmental evidence leads to a new look at our concepts of biological organization.

Charles F. Ehret

What are organelle systems and precisely how do they relate to the higher and lower levels of biological organization? Are traditional definitions of organelles as elements or as units of the cell structure still possible or desirable? Or, if our concept of the organelle has changed, then what difference does this make to theories in biology concerning the "living matter" and the "cell"? These are some of the critical questions under examination and at least partially answerable at the present time (*1*). Before the invention of the electron microscope such questions were naturally of a hypothetical nature, yet even now precise interpretations of living cells in terms of their constituent elements continue to present formidable difficulties to the biologist. However, in the past ten years, through contributions from electron microscopy, biochemistry, and microbial genetics, a sufficient degree of common order has emerged to permit a distinction of two supramolecular hierarchies below the cellular level of biological organization: that of the macromolecular aggregate and that of the organelle. Classical cytology, through light microscopy in its various forms, has provided the background for the contemporary outlook, and Wassermann (*2*) has reviewed the contributions of early workers in the field. It appears at present that the few concepts of subcellular particles that have arisen to date are fragmentary at best.

While from the present data we cannot expect a revolutionary overthrow of classical cell theory, its decline in some borderline and otherwise difficult areas (discussed below) appears inevitable. For an understanding of the borderline cases as well as for an understanding of the cell in the classical sense, at least two supramolecular hierarchies of structural organization appear to be necessary, and may indeed be sufficient. The first level has been nebulously termed lattice, polymer, crystal, colloid, or macromolecular aggregate by the solid-state physicist in or out of biology. The second, composed of the first and, in turn, composing the cell, has been similarly termed organelle (*3*). Organelles reside uniquely in the biosphere and have not yet been synthesized outside of it. It is particularly to the second level that I here address my attention.

Some Systems of Organelles in a Single Cell

One of the many instructive organisms for these studies has been the ciliated protozoan *Paramecium*. The apparently unique and complex cell surface of this little animal has been the subject of study and controversy for nearly 100 years. Zoology textbooks have long presented elaborate diagrams of the "fibrillar systems" of pellicle and gullet as figures worthy of study by the elementary student. The lesson has been essentially to point out how different this is from other cells: the fibers and ridges in the shape of chicken wire, the cell-mouth in the form of a woven cornucopia, and the bank of trichocysts militantly arranged behind the walls, ready to fire away at the enemy.

Today, another view, summarized in Figs. 1 and 2, prevails. The reconstruction techniques applied here are similar to those routinely used in studies of embryonic development, but in this case they are applied to single cells, by means of the electron microscope (*4*). The pellicle system of the cell surface is composed of two sets of closely packed organelles: the ciliary corpuscles and the trichocysts. In this simple repetitive-unit construction resides the physical basis for the ridge-and-wire patterns; the junction edges of the packed corpuscles give rise to those hexagonal and rhomboidal patterns on the surface. Beneath the surface and between the corpuscles, the trichocysts are located. Along the line of trichocysts, the cilia are found. Each corpuscle contains either one or two cilia; to the right of each ciliary base (or kinetosome) is a small pocket known as the parasomal sac. Only one sac is seen in a corpuscle, whether one or two cilia are present. From the anterior filaments of the kinetosome (the posterior kinetosome in cases where there are two), a kinetodesmal fiber extends anteriorly the distance of three or more corpuscles and laterally to the right, between the columns of corpuscles, and forms a bundle of fibers by overlapping (*4–6*) or spiraling around (*4*) other fibers of the same column (see Fig. 1, sections *A–A* and *C–C*). The hexagonal and rhomboidal complexes of organelles together form a portion of the cell surface known as the pellicle system, which, but for a small gap, entirely contains the liquid phase and inner envelope systems of the cell. Another system of similarly

The author is a staff member of the Division of Biological and Medical Research, Argonne National Laboratory, Argonne, Ill. This article is adapted from a lecture delivered 29 December 1959, during a symposium on "The Impact of Electron Microscopy on Biology," at the Chicago meeting of the AAAS.

packed organelles, the gullet or food-intake system, closes this gap. The gullet cilia are much more closely spaced than those of the pellicle, with about 0.46 micron between the centers of the kinetosomes (see cover photograph and Fig. 3*A*). However, instead of one or two cilia per parasomal sac, there are four. Since the unit organelle of the gullet system bears four cilia and one sac, three columns of about 90 of these quadriciliated units bear the approximately 1000 cilia that nearly fill the food-intake cavity. A fourth organelle complex to complete the gullet system of organelles is the non-ciliated ribbed wall, in which the inter-rib distances are similar to the inter-ciliary distances of the other three complexes.

Comparative Anatomy of Organelles as Units and in Groups

From studies such as these, several rather remarkable relationships between the components that make up the cell soon became apparent. The first and most striking is that just below the cellular level of organization there are a number of anatomically characteristic components that are identifiable as such in nearly all cells. The second is that these components, these organelles, pack together into simple and orderly arrays. To treat of the first relationship, the organelles include cilia, mitochondria, and certain laminated and concentrically layered or vesiculated objects. We shall now center our attention on some of the roles that are played by one class of organelles, the cilia.

Cilia are built in the same way wherever they are found in the plant or animal kingdom (*7*, *8*). Of equal importance has been the discovery that many organelles, bearing little superficial resemblance to cilia, are nevertheless built upon the same ultrastructural ground plan—are as similar to one another as the isotopes of an element. A striking illustration of this second point is given in Fig. 4, in which a mammalian cilium (*9*) is seen closely to resemble the connecting fibers (*cf*) between segments of the rods (*OS*, outer segment; *IS*, inner segment) (*10*) in the retina of the eye, with their nine sets of concentrically arranged filaments. Numerous equally remarkable examples of "organellar isotopy" upon the cilium ground plan can be given. The plantlike stalk of another protozoan, the colonial ciliate *Opercularia*, is composed of bundles of cilium-like fibers (*11*); the hair cells of the organ of Corti in the cochlea or inner ear of the guinea pig are tufted with cilia and cilium-like fibers (*12*); the tip of the trichocyst is cilium-like, although a clear count of 9 or 18 perimeter filaments has not been resolved (*4*); a broomstick-like structure in the protozoan *Lophomonas* (the axostylar filament) looks superficially unlike a cilium (*13*), yet it is composed of 18 (9×2) radially arranged plates about a centr[illegible] fiber and each plate has a period o[illegible] abo[illegible] 400 angstroms, like that of the typical kinetodesmal fiber (*5*).

Thus, in one form or another this versatile organelle performs a wide variety of tasks in the lowest as well as in the most complex forms of life. In man, not only does the cilium propel the male spermatozoon; it also guides the female ovum into the oviduct, helps keep the lungs free of dust, is a receptor point in vision, hearing, and balance, and is a part of the division apparatus [the centriole (*8*, *14*)] in nearly every cell of the body.

The ciliary corpuscles and trichocysts of the pellicle system and the cilia of the gullet are, of course, excellent examples of the packing together of organelles into orderly arrays. It is interesting to find ciliary complexes in certain renal tumors of the hamster [Fig. 3*B* (*15*)] that are very similar to the gullet complex of *Paramecium* [Fig. 3*A* (*16*)]. In each case, the packed cilia appear to compose considerable portions of the cell surface and

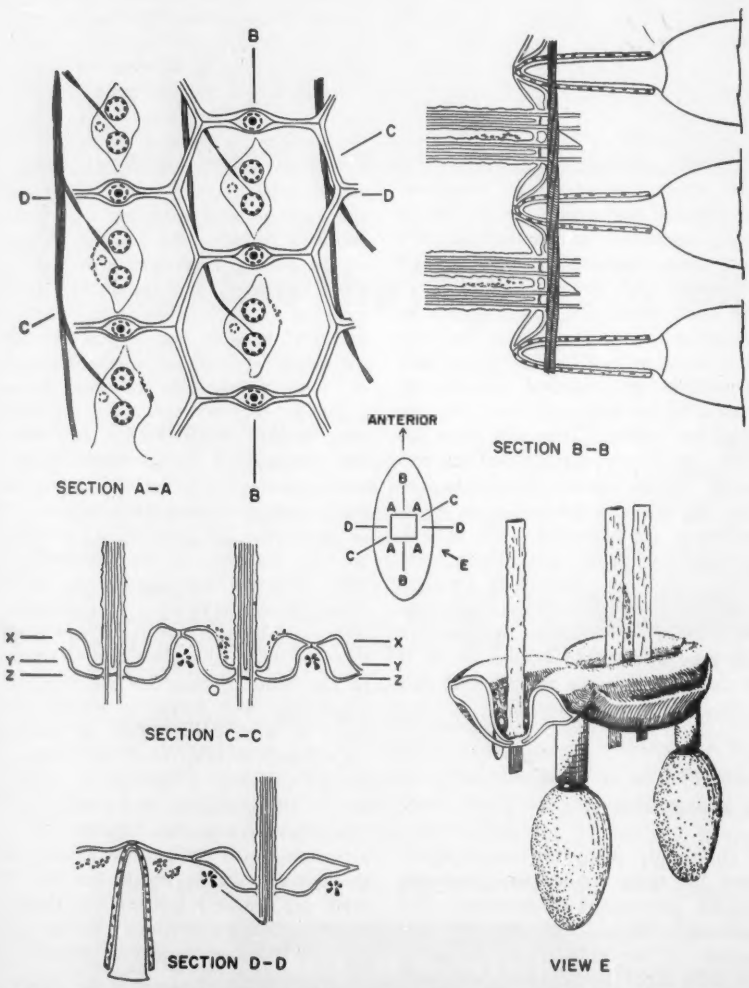


Fig. 1. Sections through plan, elevation, and profile orientations of the cell surface of *Paramecium*. The reconstruction view *E* is of two ciliary corpuscles and two trichocysts. The parasomal sac is evident on the hemisectioned forward corpuscle. Planes of sectioning are shown on the outline of the cell in the center of the figure. [From Ehret and Powers, *4*]

sometimes appear highly compacted, as in the footlike cirrus of the protozoan *Euplotes* (*17*). Whether diffuse, compact, or a composite of both patterns, sheets like these of two-dimensionally packed organelles are seen in many free-living cells to surround the cytoplasm entirely, thereby forming the outer envelope of the cell. Inner envelopes of two-dimensionally packed nonciliated units (pore complexes) (*18*) similarly compose the nuclear envelope of most cells (*19*). Arrays of three-dimensionally packed units, in some dimensions (*20*) quite like those of the pore complex, are seen in the cytoplasm and are called ergastoplasm or endoplasmic reticulum (*21*).

Similar considerations of the homologies among units and of the packing or developmental patterns of units could be, and indeed have been, made for other organelles and their complexes—particularly for the mitochondrion and structurally distinct cytoplasmic organelles (*22*). On the other hand, it is now well known that some organisms are totally devoid of such characteristic cytoplasmic organelles as *true* cilia and mitochondria—notably, the bacteria. All available evidence seems to indicate that bacteria are simple one-envelope systems, and that the larger organelles normally associated with the outer envelope of typical cells are absent. In this sense, bacteria are more like free-living nuclei than they are like typical cells. Even the most complex bacterial organelles —for example, the tubular and lamellated photosynthetic organelles of *Rhodospirillum* (*23*)—are small and simple as compared to typical mitochondria; along with chromatin, these tubular and lamellated organelles share the same "karyoplasm" and are encased by the same envelope.

As a summary to this brief exposition of the simple and orderly arrays of organelles in living systems, Fig. 5 associates graphically and extends some of the ideas just discussed. The list of terms on the right is a much abbreviated compilation of a few of the noncommittal names given to objects that we find in and around cells (compare the decision-tree in *3*). On the left are the simple space groupings appropriate to these. For example, mitochondria and multivesicular bodies (*24*) as they are found normally in cytoplasm are, like points, spatially restricted groups. As they are found in the spermium, mitochondria are chains or one-dimensional groups of points (the spiral filament, *25*). Pore complex units (*18*) exist as two-dimensional sheets of points in the nuclear envelope. The nebenkern (*26*), old nucleolus (*27*), and endoplasmic reticulum (*20, 21*) are three-dimensional lattices of mitochondrial, nucleolar, or pore-complex-like units, respectively. Of particular interest is the manner of employment of sheets as envelopes—in the case, for example, of the nuclear and outer envelopes of cells—as well as several interesting properties of the isopoly combinatorial systems of all groupings.

It may be noted, for example, that in the division of a two-envelope system, the inner envelope is usually lost at mitosis, and a cyclical transition from a two-envelope to a one-envelope system occurs. Similarly, virus propagation occurs through cyclical transitions from a one-envelope to a zero-envelope system. In each case, at organellar replication, the inner envelope system is lost. These parallels between nuclei and infected bacteria provoke the experimental question: Is a specific lysis-inducing enzyme or "lysozyme" released by metazoan nuclei just before fission to disrupt the fabric of the inner envelope, as in the case of bacterial lysis (*28*)? A rare but plausible example of a defective two-envelope

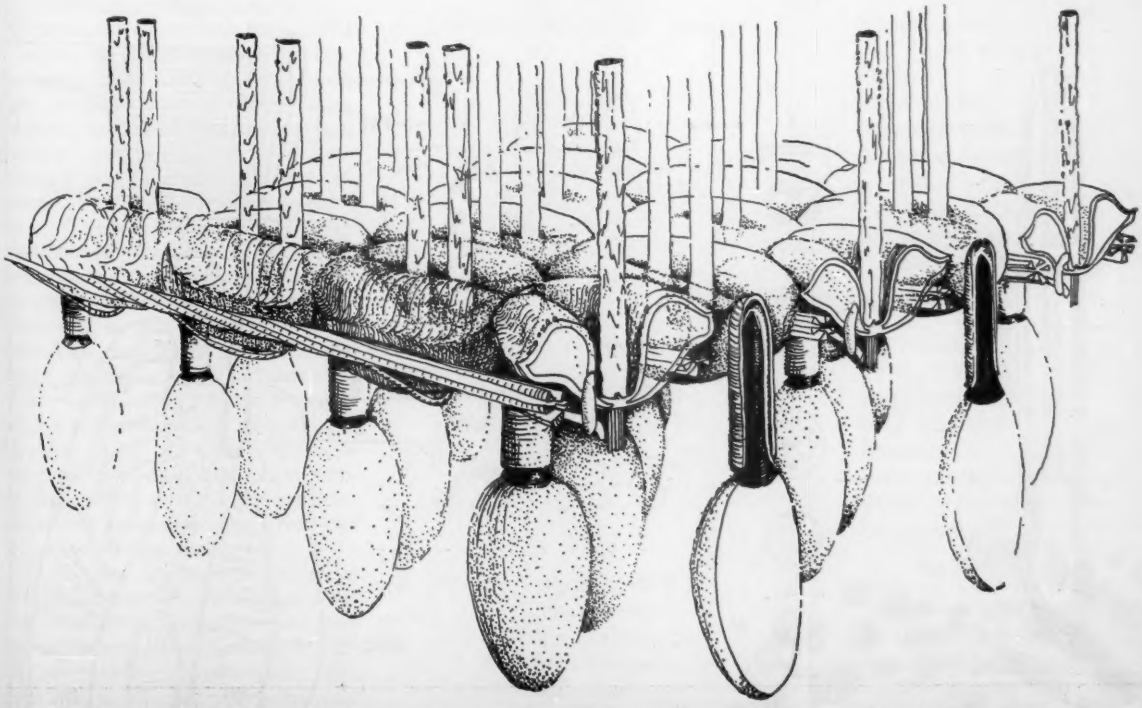


Fig. 2. Reconstruction of a region of pellicle surface composed of 18 corpuscles and attendant trichocysts. Bundles of kinetodesmal fibers link the ciliary bases and confer polarity on the whole structure. [From Ehret and Powers, *4*]

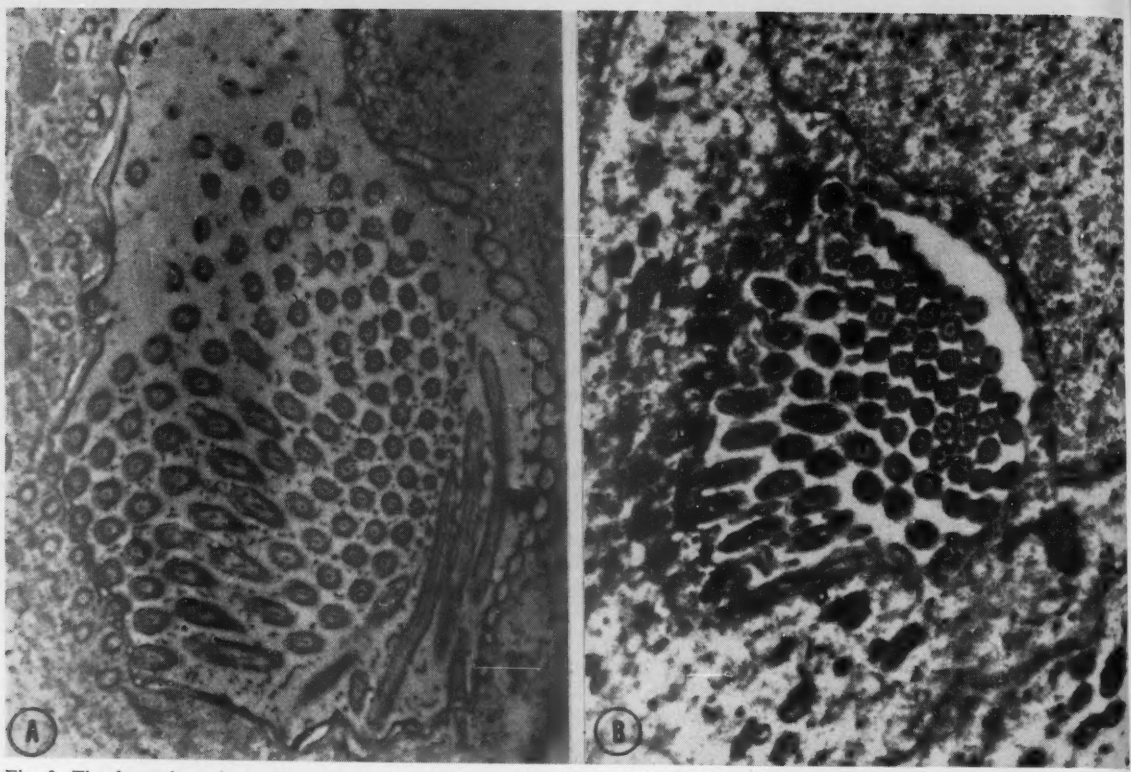


Fig. 3. The formation of two-dimensional sheets by organelle complexes in the gullet of *Paramecium* (*A*, from Ehret and Powers, *16*) and in a renal tumor cell of the hamster (*B*, from Mannweiler and Bernhard, *15*).

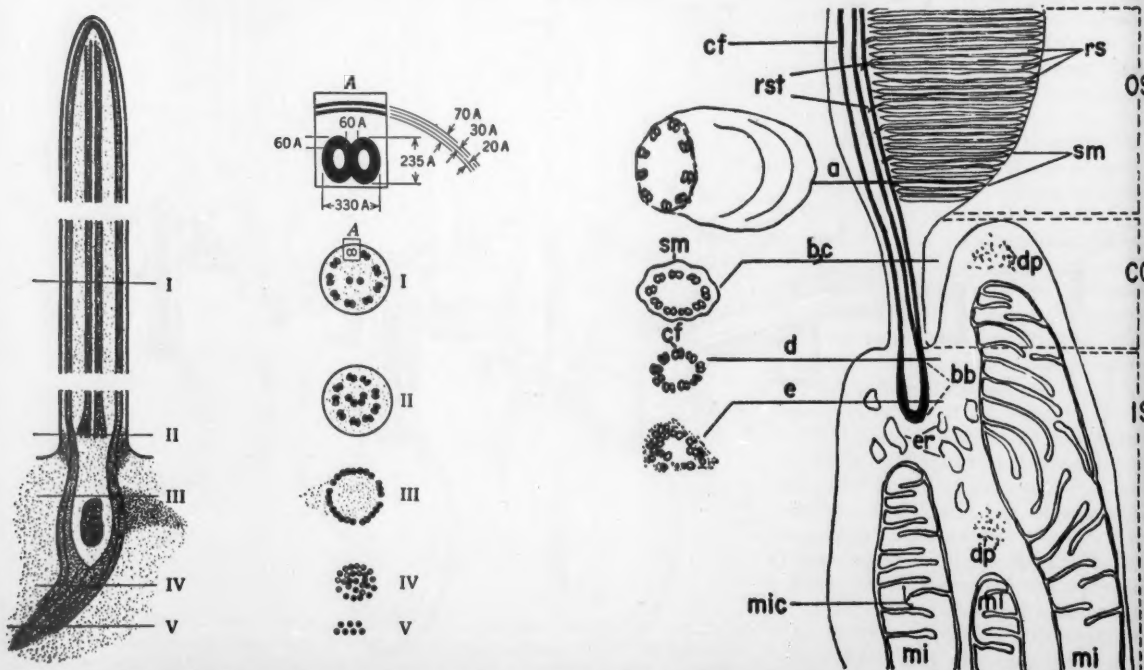


Fig. 4. An illustration of organellar isotopy, showing the cilium of mammalian tracheal mucosa on the left (from Rhodin and Dalhamn, *9*) and the connecting fiber (*cf*) of the retinal rod on the right (from DeRobertis, *10*).

system is also on record, in the case of the mammary tumor virus. Bernhard (*29*), for example, has shown that such a virus, wrapped in an inner envelope picked up earlier in its passage through the nuclear membrane of the host cell, can then acquire an outer envelope in its passage through the cell membrane. It is logically satisfying to find even the "trivial" or "improbable" mathematical possibilities nevertheless represented.

Definitions, Formulations, Perspectives

What is an organelle? The term itself suggests a miniature organ and has been casually applied to many cell parts without much regard for homology or comparative topology. A rigorous definition at this time might prove to be unduly restrictive and has been difficult to achieve for even such well-established units as atoms and molecules. Some characteristic properties are, however, worth considering. In the first place, we may classify organelles according to structure: mitochondria contain tubules, plates (lamellae), or ridges (cristae); cilia contain nine oriented sets of filaments, and this number itself may be regarded as a space-filling constant. Less effective are functional classifications according to action, enzymatic capacity, or cytochemistry, since *some* organelles lack these attributes. For example, Ephrussi's petite mutant of the yeast cell still contains structurally typical mitochondria, while lacking respiratory enzymes (*30*). Therefore, while synthetic functions may be performed upon organelles at the chemical level (*3*), the primary role of organelles is best described as a niche-filling or space-filling one. In this way, organelles are structurally supportive (for example, ciliary corpuscle or pore complex), or kinetically active (cilium or flagellum), or mechanically translational (cochlear hair). It appears probable that they have additional purely physical functions, such as transmission, diffraction, oscillation, and reception of electromagnetic energy (*31*).

If we think of the organelle as an ordered laminate of heterogeneous macromolecular aggregates, we may find its prototype best exemplified by the plant and bacterial viruses, with their protein wrappers and nucleic acid cores (*32*). A structurally similar laminate of lipopolysaccharide and protein is the receptor site unit of the bacterial cell wall for the bacterial virus T-5 (*28*). Analogous laminates of other macromolecular aggregates such as lipids and protein were proposed as the ultrastructural basis of membranes, even before the invention of the electron microscope, especially from results with polarized light and x-ray diffraction methods. Along these lines, the pioneering studies of Frey-Wyssling (*33*), Seifriz *et al.* (*34*), Davson and Danielli (*35*), F. O. Schmitt (*36*), and many others have been substantiated and extended (*31*, *37*), and the principal continuing emphasis in electron microscopy is quite justifiably at this lower level of the macromolecular aggregates. However, it is equally necessary at the organelle level to characterize the consequences of multiplicities and groupings of organelles in the formation of the large space-filling and macrokinetic devices of the cell.

The way in which these components may be used in quantitative formulations of cell structures is shown in Fig. 6. In this treatment, each of the organelles of the surface is regarded as an isotope of a "type cilium" and is symbolically represented by roman letters and appropriate superscripts. In the case of the ciliary corpuscles, the superscripts refer to the number of cilia per unit; the units c^1, c^2, and c^4, despite differences in ciliary count,

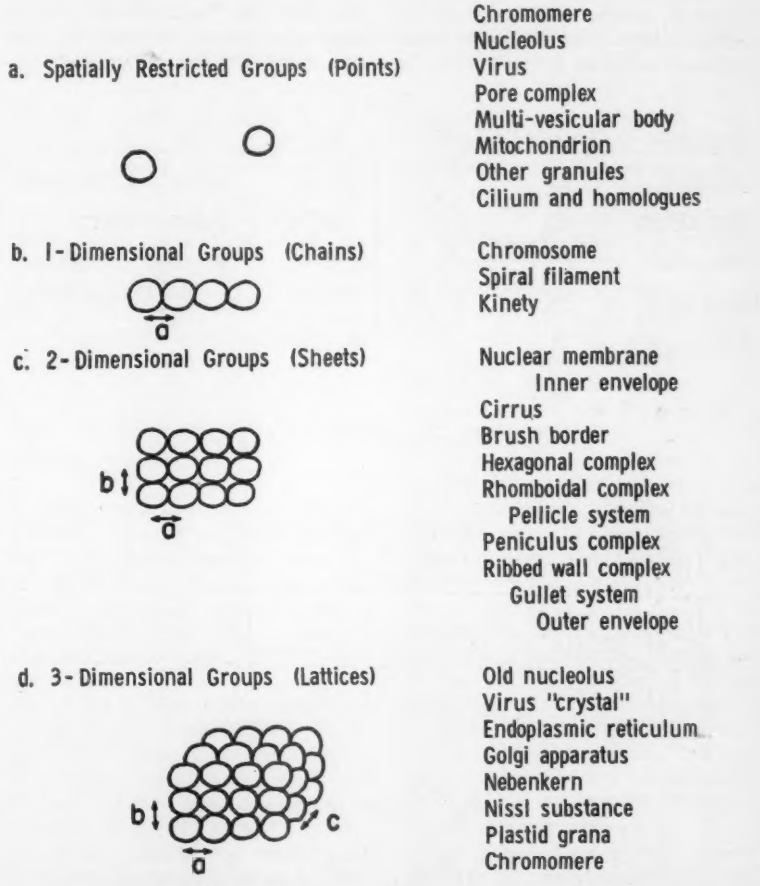


Fig. 5. The organelles, alone and in bunches: the formally simplest packing groups of organelles and some of their cytological and etymological consequences.

possess single sacs, occupy closely comparable areas of the surface space, and appear to arise in each case from single C^0 units. The forces that hold these units to one another are represented by valence bond lines. Ultrasonic disruption (*5*), as well as compression-decompression studies (*38*), suggest that the weakest of these bonds is that binding trichocyst to corpuscle, and the strongest, that binding corpuscle to corpuscle by way of the kinetodesmal fibers. The central diagram of the hexagonal complex $(c^1t)_{14,000}$ of the pellicle system of the cell surface shows the essential relationships between bonds and the approximately 28,000 units involved. For simplicity, the curved lines representing bonds between corpuscles by way of the kinetodesmal fibers are shown to influence only longitudinally adjacent corpuscles; in reality each corpuscle is bound by such forces to three or more posteriorly and anteriorly located corpuscles. The relationship of *t*'s to *c*'s is shown only in profile view. The force diagram of the disposition of trichocysts along the surface suggests that even if no other function is served by them, they must at least contribute to the structural strength of the pellicle system by serving as footings and trusses between the hexagons and the viscous gel of the cytoplasm. *Paramecium* has thus solved, in an ingenious fashion not yet patented by the construction engineer, the problem of trusswork among the hexagons of a nonrigid geodesic dome (*39*). The superficial resemblance between such a diagram and the cytologist's pictorial equivalent (Fig. 1) arises only out of topological necessity. In this way it also resembles the conventional formulations of molecules in terms of their constituent elements. From such systems formulations it should be possible for an anonymous investigator, given the properties of the units and their bonds, to specify the properties of the whole figure, including its "appearance."

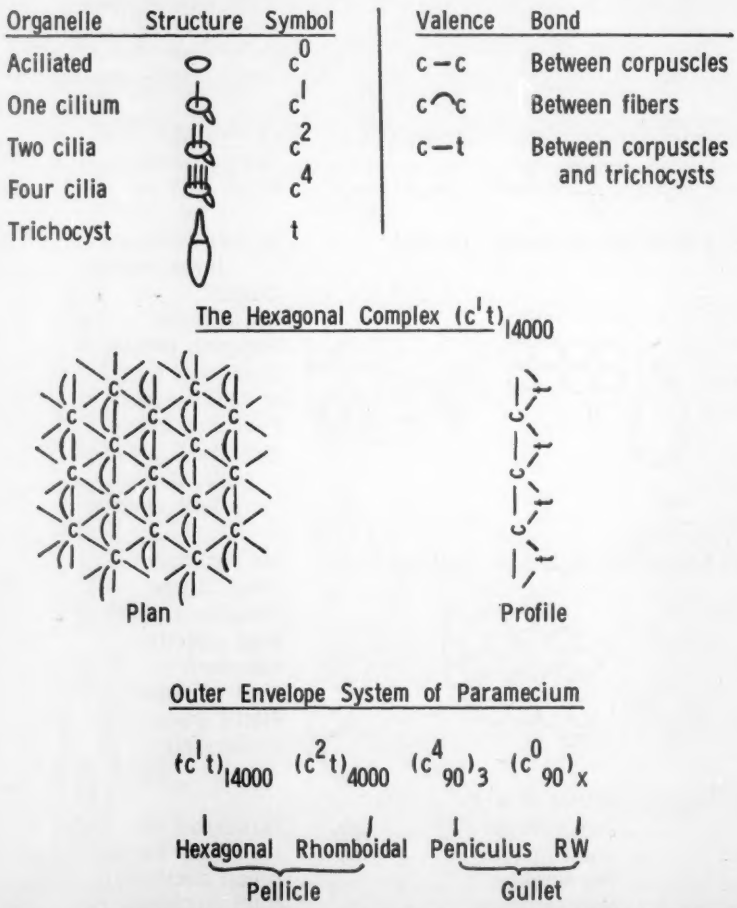


Fig. 6. Systems formulations in terms of organelles: the representation of cytological structures in a single cell by means of equations for, and graphs of, its constituent organelles.

Such formulations are justified because they can describe biological organizations not only for the exposed surfaces of *Paramecium* but also for analogous configurations in the nuclear envelope, in the organ of Corti, and in the Hamster renal tumor. Furthermore, most of the genetic mappings of the past 50 years are once-removed transformations of similar structural formulations. This perspective also clarifies the dual physical basis for genetic maps. The first, the subject of viral genetics, is at the molecular level and is associated with the transposition and alteration of extremely short sequences of nucleotides (*40*). The second, the subject of the bulk of classical genetics, is at the organelle level and is associated, accordingly, with much larger "chromomeric" transpositions. Each is of importance, and the primitive organisms that lack the second are deprived of a whole range of recombinational potential acquired by higher organisms through their chromosomes. Genetics is, therefore, basically a structural science concerned with the linear ordering of particles at two levels, and whether he admits it or not, the geneticist is a morphologist at heart.

Statics versus Dynamics

If the ultimate justification for this kind of approach is a better understanding of the dynamically active living organism (*41*), how can this understanding be derived from the frozen-points static concept described above? First, let us recognize that all particle concepts suffer from illusions of the reality of a static point, and the molecular-submolecular even more than the supramolecular concepts discussed here. With the long interfission times of cells, the actual disposition of organelles may remain architecturally unchanged and essentially as shown in Fig. 2 and Fig. 6 for hours or days; yet at the molecular level, within the very substance of these organelles the interacting particles of the metabolic cycles have relatively infinitesimal lifetimes. But as fission approaches, drastic changes occur in the organelle groupings of the nucleus and cytoplasm of the cell. The mechanisms

of deoxyribonucleic acid and of chromosomal duplication have been under extensive study recently, and I will mention them only briefly here. Suffice it to say, for comparative purposes, that in each of the several interpretations that have been applied to the data (*42*) the essential genic and chromosomal material does not appear to grow and split in two (division) but, rather, appears to be synthesized and ordered *de novo* on a template provided by the old (replication).

How do extranuclear organelles compare? Our own approach to the problem has been to isolate and observe single cells just before cell division. The most interesting changes have occurred by the time the fission furrow is even faintly visible, and most published accounts of gullet "budding" in *Paramecium* are actually descriptions of these stages in displacement of already well established new organelle systems from the old ones. But these are late stages. The first signs of the new gullet appear at the pellicle surface in the region of the vestibulum, many microns removed from the old gullet. An alignment into three columns of about 90 granules per column occurs. From each granule, four cilia sprout, and the cell is now equipped with three ribbons of cilia, still essentially at the surface and more specifically influencing the swimming than the feeding of the organism. Invagination and posterior displacement occur in much slower succession than do the preceding stages, a fission furrow forms, and the cell divides. The fission furrow is also filled with granules, from which one or two cilia appear to sprout.

Most of these events are established only through phase-contrast microscopy, and the full description of details observed with electron microscopy is in progress. Daughter cells resemble one another and their common parent not as mirror images but directly; this appears to be the consequence not of a template-replica mechanism but, instead, of a developmental process in which the new organelle systems are ordered by less specifically shaped but sufficient environmental forces. In each daughter cell nearly half of the old organelle systems are preserved intact and without gross change—like the old section of a building to which a new wing has been added. To date, no satisfactory evidence of the division of ciliary bases (kinetosomes) has appeared (but see *6*, *43*, *44*), and the alternative hypothesis that these organelles arise neither by division nor by replication but *de novo* (by biosynthesis and development from suborganellar-level pools) is strongly favored by the *Paramecium* studies. The alternatives remain to be resolved empirically but are best understood in the first place within the framework (Fig. 7, discussed below) of the choices open to the units that compose the organism at each appropriate level of complexity.

SET	SUBSETS
MOLECULE (M) (glycine; adenine; ATP)	Atoms and non-atoms: $A_1 A_2 A_n P_{1-n}$
MACROMOLECULAR AGGREGATE (C) (ribonuclease; DNA)	Molecules and non-M's: $M_1 M_2 M_n A_{1-n}$
ORGANELLE (O) (virus; chromomere; cilium)	Macromolecular aggregates and non-C's: $C_1 C_2 C_n M_{1-n}$
ENVELOPE SYSTEM TWO ENVELOPE (S") ONE ENVELOPE (S') (epithelial cell) (bacterium)	Organelles and non-O's: $O_1 O_2 O_n C_{1-n}$
TISSUE (T") (T') (epithelial tissue) (bacterial colony)	Envelope systems and non-S's: $S_1 S_2 S_n O_{1-n}$

Fig. 7. Relationships between components and systems of organelles: some molecular and supramolecular sets of the bios.

From Macromolecules to Envelope Systems

Quite recently a vigorous concern for relational schemes and levels of biological organization has been shown by a number of usually empirically oriented biologists (*44–46*). A crux of their problem is invariably resident in our inadequate notions of the ultrastructure of living systems. In Fig. 7 I have tried to relate such components to one another in the simplest possible hierarchal fashion. Despite the simplicity of this scheme, the physical basis for each of the relationships discussed above is represented here, the gap between the molecular and cellular levels is realistically bridged, and some interesting properties of the products of components are implied. (Below the molecular level, and above the tissue level, particles and atoms, and organs and organisms, might also appear as component elements of the bios.) Each set is composed not only of its immediately inferior subsets but also of more remotedly inferior components. Thus, free radicals or negatively charged particles may be subset components of a particular macromolecular aggregate or molecule. The scheme thereby allows for a wide variety of hybrid sets that fit no simple specification *M*, *C*, or *O*. The composition of a tendon, for example, might better be considered a *C–M* structure [of the protein collagen in a relatively diffuse molecular matrix of mucopolysaccharide molecules (*46*)] than an organelle, which is a laminated aggregate of *C*'s. Since the term *cell* is more appropriately applied to a uninucleated two-envelope system, the more general class "envelope systems" is recognized as the component that makes up tissues. Two classes of tissues are therefore recognized, those derived from one-envelope systems and those derived from two-envelope systems. It is the latter line, with its manifold possibilities for recombination of components, that provides the stem-line for the higher forms of plant and animal life. (It is interesting to note that sanitation and fermentation biologists have noted the equivalent of *S'-T'* "organs" in their vats and sludges.)

Above the *O* level, examples can be cited for sets possessing the divisional property: the two split members of the set are isomorphic or homeomorphic to one another and to the unsliced parent set. Below the *C* level it is not possible to divide and preserve homeomorphy of the parent and the fission elements. A practical consequence in metazoan biology is that identical twins

resemble one another not because they or their tissues or cells are replicas of one another but because of a remote event subsequent to gene sequence replications in their common zygote. All superior systems were synthesized uniquely and developed epigenetically *de novo*, as in the equally nonreplicative case of ice-crystal patterns on a cold windowpane or of gullet development at another surface. From this example and from microbial data it appears that at only one point on the scheme does replication enter the picture from necessity rather than fancy: at the *C* level, in the inheritable sequences of viral or chromosomal nucleotides.

When Is an Envelope System Not a Cell?

One of the most interesting distinctions highlighted here is the distinction existing between single- and multiple-envelope systems, in which the object conventionally and restrictively termed "cell" is regarded as a special case of the latter grouping and bacteria are regarded as prime examples of the former. Are bacteria then not cells? Some people insist that bacteria are cells because the cell is the basic unit of life and, as everyone knows, bacteria are alive! Others say, looking back to Hooke, that they are cells because they are shaped like cells, which are tiny rooms inhabited by monks. Still others say they are cells because they have deoxyribonucleic acid, ribonucleic acid, and a quite respectable genome. Needless to say, each argument is either circular or insufficient in itself to categorize uniquely the organizational stratum that is appropriate to a bacterium. More cogent reasons would be the presence of a typical nucleus within a typical cytoplasm. What is typical? The contemporary experts agree unanimously that ultrastructurally the *bacterial* flagellum is not a typical flagellum [lacking the cilium-like filamentous order (*47*)]; that the *bacterial* mitochondrion is not typical [being orders of magnitude smaller, though not necessarily lacking some form of lamellated or tubular ultrastructures not unique to cytoplasm (*48*)]; and that the *bacterial* nucleus is not typical [lacking the characteristic nuclear envelope (*49*)]. When we speak of a "bacterial this-or-that" we deliberately so modify our object as to remove it from the framework of rigorous structural homology with other objects not so modified (whereas set theoretic terms point up the likenesses as well as the differences among categories). Because atoms have nuclei, as do ethnic social groupings, it would be preposterous to presume rigorous structural homologies to be present between them and cellular nuclei, even though they all may share in common interesting topological properties. It is, therefore, quite an unfortunate, though an understandable, etymological turn of events that two distinctly different biological objects share nearly the same name, to the point of confusing all but the nonexperts in the field.

The homely term *cell* will and should continue to be used both colloquially and specifically by the biologist. However, in restrictive matters, when properties of the units are claimed or sought (such as "nuclei" and "mitotic-spindles"), then his units should be unambiguously defined, preferably in operational systems-theory terminology.

Transcendency of Levels

It would be premature to declare, "the proof is in, all bacteria are one-envelope systems and are therefore homologous to the archaic 'nucleus.'" The point that I make is this: the properties of the bacterial species, as well as of those actinomycetes adequately studied to date, seem to indicate that they fit the one-envelope level of organization better than any other. Is it not conceivable that some species are multi-enveloped or even zero-enveloped? Indeed, is not a transcendency of levels formally plausible, so that within a life cycle many levels might be manifested by a single organism? Perhaps the filterable forms of bacteria, including the so-called L-forms and pleuropneumonia and pleuropneumonia-like organisms, are a manifestation of such transcendency from the zero- (virus-like, filterable elementary bodies) envelope level to the one-envelope level of organization. Certainly this capacity for transcendency in levels superior to the cellular is one of the splendid evolutionary innovations of the metazoa, and its counterpart ought to be sought elsewhere. Most important, a formal realization of the general phenomenon is provocative: What are the limiting rules of the game, within what boundaries may the phenomenon operate? The answers are beyond most biologists' present competence, but the questions may sharpen us to the task.

Conclusion

Within this reference-frame of understanding, the cell ceases to occupy a central location as a fundamental unit of life. It appears, instead, as a special case among the single- and multiple-envelope systems that comprise all forms of life. The typical interphase cell is a two-envelope system whose inner envelope contains an intact genome resident upon the linearly packed chromomeres, and whose outer envelope encases the distinctive cytoplasmic organelles. However, other mathematically plausible possibilities are also found. The inner envelope is frequently represented many times, as in multi-nucleate protozoa and mammalian muscle. The inner envelope is sometimes lost or absent, as in mammalian red cells and certain mutant protozoa and typical cells in metaphase. Examples of organisms whose "outer" envelope is absent are the bacteria and actinomycetes (*50*). Being one-envelope, "inner-envelope" systems, these *protobiotes* are drastically distinguished not only from plants and animals but also from cells. Finally, certain deficient two-envelope systems are recognizable in the form of some of the mammalian viruses, and zero-envelope systems, in the form of the bacterial viruses—neither of which is capable of reproduction without the intact genome of another inner-envelope system.

The synthetic biologist is at nearly the same stage in the development of his science that the synthetic chemist had reached in Dalton's day, and no one has as yet constructed organelles from their constituent macromolecular aggregates. However, some promising attempts have been made at virus development in vitro, and the transplantation of entire inner-envelope systems into different outer envelopes has become routine in some laboratories (*51*). It is not unreasonable to expect to see certain of the simpler cell organelles synthesized in many laboratories within the next few years; their assembly into single- or multiple-envelope systems will indeed present a more difficult, but exciting, challenge.

In one sense, despite the combined efforts of hundreds of microscopes, thousands of investigators, and countless research papers, we have barely scratched the surface of the biotic landscape, and there is much work ahead. In another sense, we have some cause to rejoice, as did the tunnel-diggers

who joined hands in the middle of the mountain when the first rays of light broke through. Electron microscopy has succeeded in forming a thin but actual join between the molecular and the cellular levels of biological organization. In so doing, it has united form with function and has established the foundations of a mathematically rigorous morphology (*52*).

References and Notes

1. This work was performed under the auspices of the U.S. Atomic Energy Commission.
2. F. Wassermann, introduction to the symposium "The impact of electron microscopy on biology," at the Chicago meeting of the AAAS, December 1959.
3. C. F. Ehret, in *Symposium on Information Theory in Biology*, H. Yockey, R. Platzman, H. Quastler, Eds. (Pergamon, London, 1958), p. 218.
4. C. F. Ehret and E. L. Powers, *Intern. Rev. Cytol.* **8**, 97 (1959).
5. C. B. Metz, D. R. Pitelka, J. A. Westfall, *Biol. Bull.* **104**, 408 (1953).
6. A. Sedar and K. R. Porter, *J. Biophys. Biochem. Cytol.* **1**, 583 (1955).
7. D. W. Fawcett and K. R. Porter, *J. Morphol.* **94**, 221 (1954); W. T. Astbury, *Symposia Soc. Exptl. Biol.* **9**, 1 (1955).
8. C. Rouiller and E. Fauré-Fremiet, *J. Ultrastructure Research* **1**, 289 (1958).
9. J. Rhodin and T. Dalhamn, *Z. Zellforsch. u. mikroskop. Anat.* **44**, 345 (1956).
10. E. DeRobertis, *J. Biophys. Biochem. Cytol.* **2**, 319 (1956); K. Tokuyasu and E. Yamada, *ibid.* **6**, 225 (1959).
11. C. Rouiller, E. Fauré-Fremiet, M. Gauchery, *Exptl. Cell. Research* **11**, 527 (1956).
12. H. Engström and J. Wersäll, *Exptl. Cell. Research Suppl.* **5**, 460 (1958).
13. H. W. Beams, T. N. Tahmisian, E. Anderson, B. Wright, *J. Biophys. Biochem. Cytol.*, in press.
14. E. deHarven and W. Bernhard, *Z. Zellforsch. u. mikroskop. Anat.* **45**, 378 (1956); M. Bessis and J. Breton-Gorius, *Bull. microscop. appl.* **7**, 54 (1957); S. Amano, *Cytologia (Tokyo)* **22**, 193 (1957).
15. K. Mannweiler and W. Bernhard, *J. Ultrastructure Research* **1**, 158 (1958).
16. C. F. Ehret and E. L. Powers, *J. Protozool.* **4**, 55 (1957).
17. L. E. Roth, *J. Biophys. Biochem. Cytol.* **2**, suppl., 235 (1956).
18. M. Watson, *ibid.* **6**, 147 (1959).
19. L. Rebhun, *ibid.* **2**, 93 (1956); S. Wischnitzer, *J. Ultrastructure Research* **1**, 201 (1958); G. D. Pappas, *J. Biophys. Biochem. Cytol.* **2**, 431 (1956).
20. W. Bernhard, *Exptl. Cell Research Suppl.* **6**, 17 (1958).
21. K. R. Porter, *J. Histochem. and Cytochem.* **2**, 346 (1954).
22. E. L. Powers, C. F. Ehret, L. E. Roth, O. T. Minick, *J. Biophys. Biochem. Cytol.* **2**, suppl., 341 (1956); A. J. Hodge, *ibid.* **2**, 597 (1956); C. Rouiller and W. Bernhard, *ibid.* **2**, 355 (1956); K. E. Wohlfarth-Bottermann, *Protoplasma* **49**, 231 (1958); H. Fernández-Morán, *Exptl. Cell. Research Suppl.* **5**, 586 (1958); C. Oberling, *Intern. Rev. Cytol.* **8**, 1 (1959); J. André, *J. Ultrastructure Research* **2**, 288 (1959); A. M. Jezequel, *ibid.* **3**, 210 (1959).
23. D. D. Hickman and A. W. Frenkel, *J. Biophys. Biochem. Cytol.* **6**, 277 (1959).
24. J. R. Sotelo and K. Porter, *ibid.* **5**, 327 (1959).
25. D. Fawcett, *Intern. Rev. Cytol.* **7**, 195 (1958).
26. T. N. Tahmisian, E. L. Powers, R. L. Devine, *J. Biophys. Biochem. Cytol.* **2**, suppl., 325 (1956).
27. C. F. Ehret and E. L. Powers, *Exptl. Cell Research* **9**, 241 (1955); N. K. Das and M. Alfert, *Anat. Record* **134**, 548 (1959).
28. W. Weidel in *Virus* (Univ. of Michigan Press, Ann Arbor, 1959).
29. W. Bernhard, *Cancer Research* **18**, 491 (1958).
30. B. Ephrussi, personal communication.
31. H. Fernández-Morán, *Revs. Modern Phys.* **31**, 319 (1959).
32. M. F. Perutz, *Research (London)* **12**, 326 (1959).
33. A. Frey-Wyssling, in *Macromolecules in Cell Structure* (Harvard Univ. Press, Cambridge, 1957).
34. W. Seifriz, Ed., *A Symposium on the Structure of Protoplasm* (Iowa State College Press, Ames, 1942).
35. H. Davson and J. F. Danielli, *The Permeability of Natural Membranes* (Cambridge Univ. Press, New York, 1952).
36. F. O. Schmitt, *Physiol. Revs.* **19**, 270 (1939).
37. ———, *Revs. Modern Phys.* **31**, 455 (1959); F. S. Sjöstrand, *ibid* **31**, 301 (1959).
38. C. F. Ehret, unpublished observations.
39. R. B. Fuller, *Consulting Engr.* **13**, 90 (1959).
40. S. Benzer, *Proc. Natl. Acad. Sci. U.S.* **45**, 1607 (1959).
41. P. Weiss, *Revs. Modern Phys.* **31**, 11 (1959).
42. C. Levinthal, *Proc. Natl. Acad. Sci. U.S.* **42**, 394 (1956); J. H. Taylor, P. S. Woods, W. L. Hughes, *ibid.* **43**, 122 (1957); M. Meselson and F. W. Stahl, *ibid.* **44**, 671 (1958); R. Williams, *Revs. Modern Phys.* **31**, 233 (1959).
43. E. Chatton, A. Lwoff, M. Lwoff, *Compt. rend.* **188**, 1190 (1929); A. Lwoff, in *Problems of Morphogenesis in Ciliates* (Wiley, New York, 1950).
44. A. Lwoff, *J. Gen. Microbiol.* **17**, 239 (1957).
45. T. M. Sonneborn, *Nature* **175**, 1100 (1955); F. O. Schmitt, *Revs. Modern Phys.* **31**, 5 (1959); R. Zirkle, *ibid.* **31**, 269 (1959); S. E. Luria, in F. M. Burnet and W. M. Stanley, Eds., *The Viruses* (Academic Press, New York, 1959); B. Strehler, *Quart. Rev. Biol.* **34**, 117 (1959); S. Wright, *Science* **130**, 959 (1959).
46. F. Wassermann, *Ergeb. Anat. u. Entwicklungsgeschichte* **35**, 240 (1956).
47. B. A. D. Stocker in E. I. C. Spooner and B. A. D. Stocker, Eds., "Bacterial flagella: morphology, constitution and inheritance," *Proc. Soc. Gen. Microbiol., 6th Symposium, London* (1956).
48. S. Mudd, *Bacteriol. Revs.* **20**, 268 (1956).
49. E. Kellenberger and A. Ryter, *Schweiz. Z. allgem. Pathol. u. Bakteriol.* **18**, 1122 (1955); P. Giesbrecht, *Naturwissenschaften* **45**, 473 (1958); S. Spiegelman, A. I. Aronson, P. C. Fitz-James, *J. Bacteriol.* **75**, 102 (1958); G. B. Chapman, *ibid.* **78**, 96 (1959); E. Kellenberger, in "The physical state of the bacterial nucleus," *Proc. Soc. Gen. Microbiol., 10th Symposium, London*, in press.
50. R. T. Moore and G. B. Chapman, *J. Bacteriol.* **78**, 878 (1959).
51. R. Briggs and T. J. King, *J. Morphol.* **100**, 269 (1957).

52. I gratefully acknowledge the assistance of my colleagues, particularly E. L. Powers, F. Wassermann, and R. B. Webb, during the development of this article.

Trends in Polarography

J. Heyrovsky

For some 38 years I have carried on electrochemical research with the dropping-mercury electrode because of its exquisite properties as electrode material. Its physical conditions of dropping as well as the chemical changes that occur during the passage of the electric current are well defined, and the phenomena displayed at the dropping-mercury electrode proceed with strict reproducibility. Owing to the latter property the processes of the electrode can be exactly expressed mathematically. According to the registering apparatus, called a "polarograph," which automatically draws curves characteristic of the electrode processes, the electrochemical studies with the dropping-mercury electrode and the analytical method developed on the basis of these investigations have been called "polarography."

The author, winner of the Nobel prize in chemistry for 1959, is affiliated with the Polarographic Institute, Czechoslovak Academy of Sciences, Prague, Czechoslovakia. This article is the text of his Nobel lecture, delivered 11 December 1959 in Stockholm. It is published with the permission of the Nobel Foundation.

Apparatus

The capillary electrode is normally a tube 8 centimeters long and 5 to 6 millimeters wide with an inner bore of 0.05 to 0.1 millimeter (Fig. 1), from which the drops of mercury fall off every 3 to 6 seconds, according to the height of the mercury reservoir, which is about 40 centimeters above the tip of the capillary.

In order that the current passing through this electrode may be entirely governed by the composition of the solution surrounding it, the second electrode has to be indifferent, unpolarizable, and of a constant potential; most suitably, it is the layer of mercury at the bottom of the electrolytic vessel (Fig. 2).

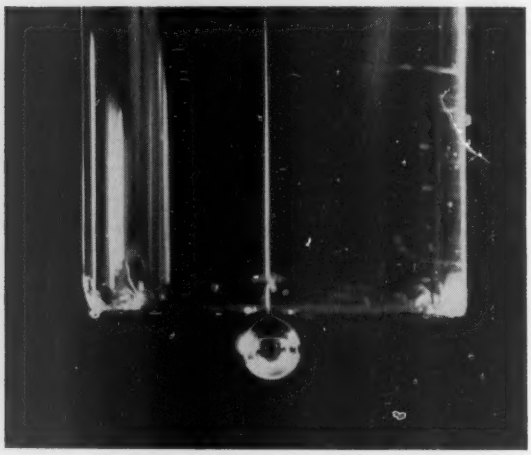
To apply the external voltage to the cell we use a potentiometric arrangement, shown in Fig. 2. From a 2- or 4-volt lead accumulator, an increasing voltage E is branched off, and the corresponding current is determined by

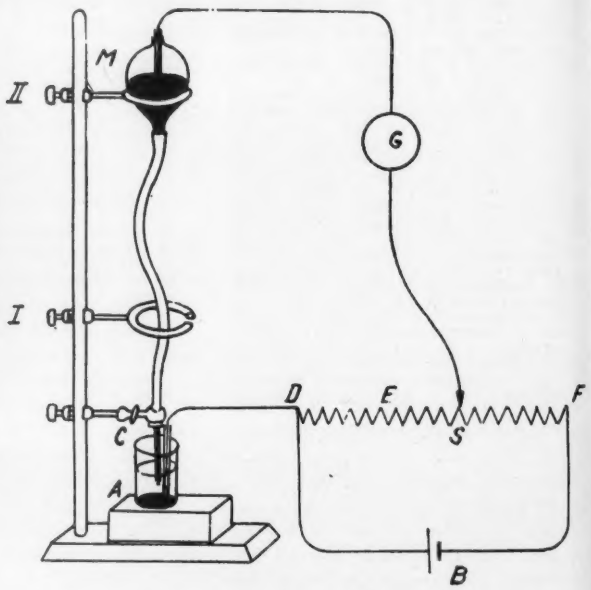
the deflection of the galvanometer. In such an arrangement the whole applied voltage E acts at the small polarizable electrode and determines its potential. The solution has to be conductive by an indifferent electrolyte (about 0.1 normal).

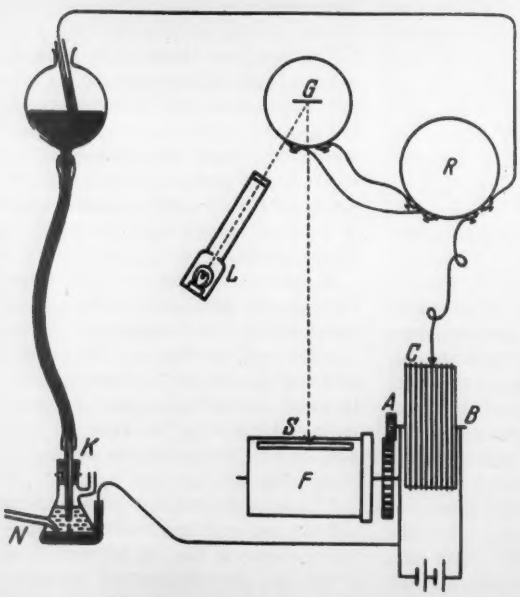
Until the year 1924 the galvanometer deflections were plotted by hand on the ordinate against the voltage applied by pushing the wheel of the Kohlrausch drum to different values. It took a couple of hours to obtain a full graph, point by point, from 0 to 2 volts. To accelerate the plotting of the curves, Shikata and I constructed in 1924 (*1*) an automatic device, the "polarograph" (Fig. 3), by rotating the Kohlrausch drum mechanically and by synchronously moving a photographic paper. This mechanism drew the current-voltage diagram—the "polarogram"—in less than 10 minutes, with all the advantages of automatic recording. The galvanometer has to be damped to register the mean current, instead of the instantaneous current, during each drop. It is not advisable to damp the motion of the galvanometer mirror so far that the oscillations disappear; the regularity of the oscillations provides a good check of the correct functioning of the apparatus (Fig. 4).

"Charging" and Kinetic Currents

Next, the forms of the current-voltage curves were classified according to the various processes occurring at the dropping electrode. The most fundamental of these is the "charging" current which accompanies every drop formation, conveying to the drop the charge corresponding to the externally applied potential. Since this charge depends on the capacity of the dropping electrode and does not involve any electrolytic changes, the current is also termed "capacity current" or "nonfaradic current" (Fig. 5). It is very small, of the order of 10^{-7} ampere per







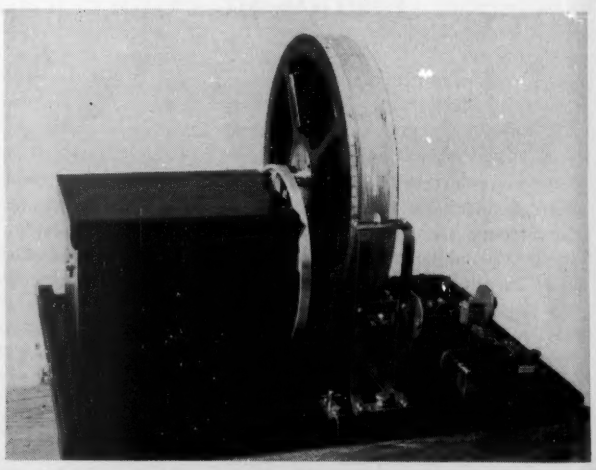


Fig. 1 (top left). Mouth of the dropping-mercury electrode. Fig. 2. (top right). The simplest polarographic arrangement. Fig. 3 (bottom left). Scheme of the polarograph. Fig. 4 (bottom right). The first polarograph.

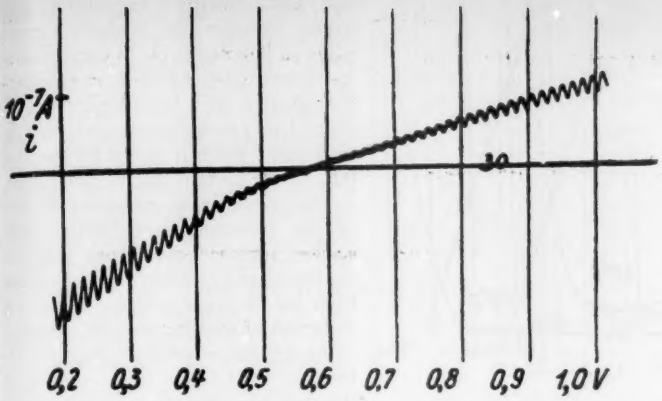
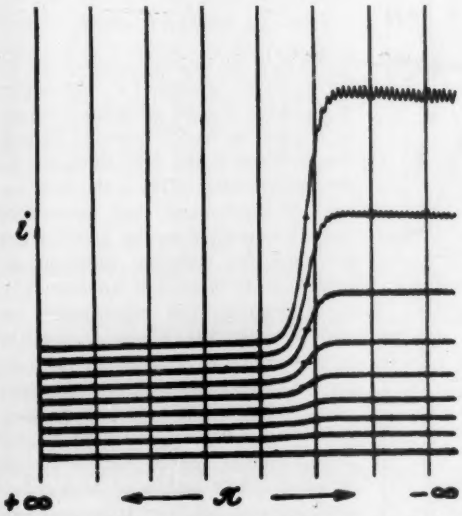


Fig. 5 (left). Capacity current in 0.1*M* KCl freed from air. Fig. 6 (right). Diffusion current of oxygen reduction in 0.1*M* KOH. The curve is repeated to show the reproducibility.



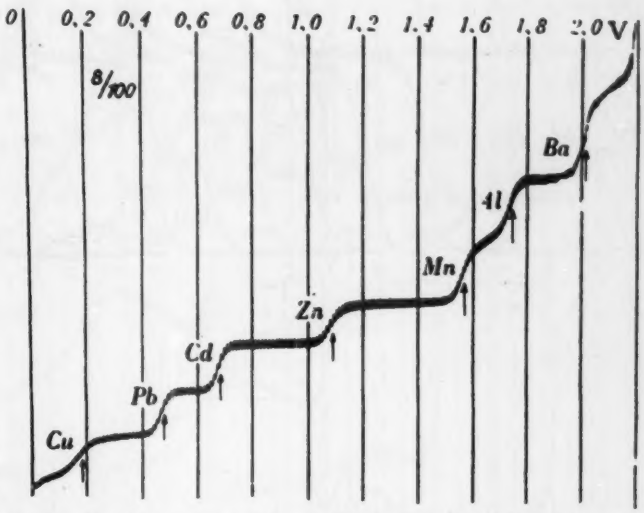


Fig. 7 (left). Constancy of the half-wave potential in solution of various concentrations of $CdCl_2$. Fig. 8 (right). Polarographic spectrum showing seven cations in the solution.

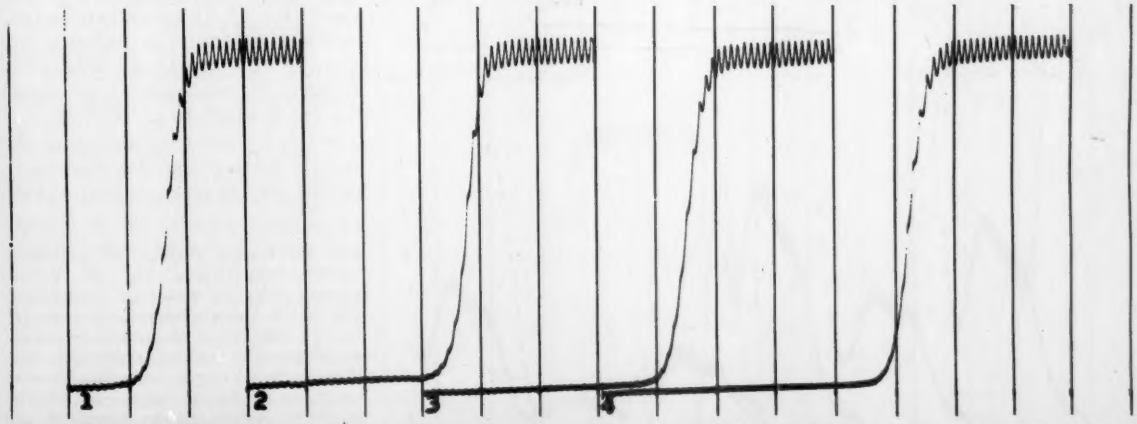


Fig. 9. Shift of the reduction wave of Pb^{++} ions due to the increasing concentration of NaOH. The curves start from the potential of −0.28 v from the saturated calomel electrode. Abscissa, 100 mv. Concentration of lead ions, $5.10^{-4}M$. Concentration of the electrolyte: (1) 1*M* KNO_3; (2) $1.2 \times 10^{-4}M$ NaOH, 1*M* KNO_3; (3) 0.1*M* NaOH, 0.9*M* KNO_3, 1*M* NaOH.

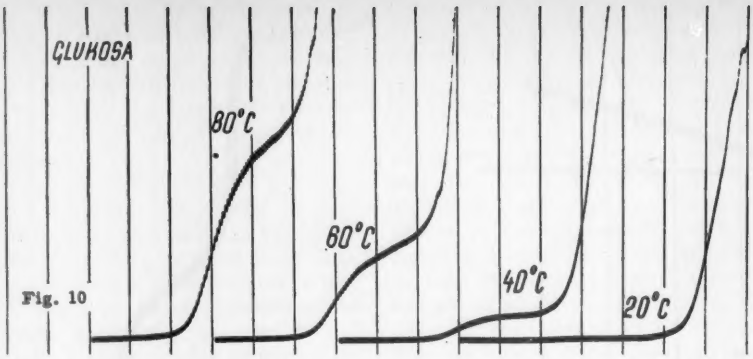


Fig. 10

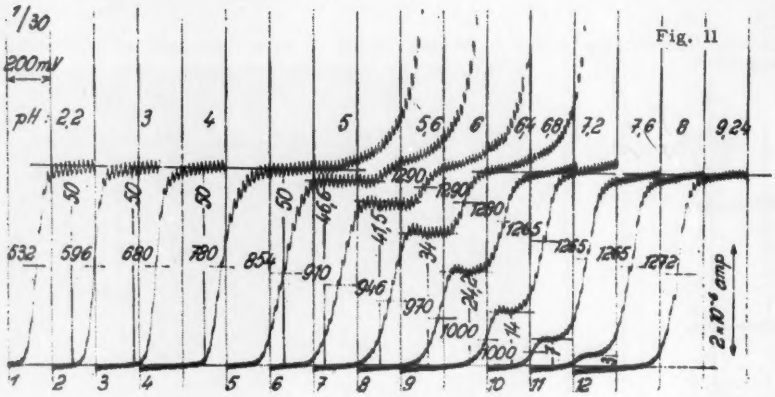


Fig. 11

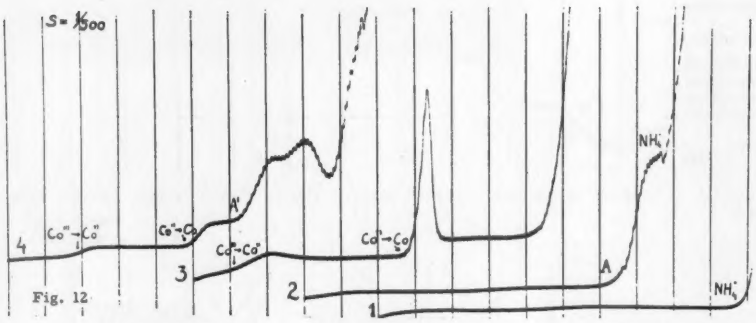
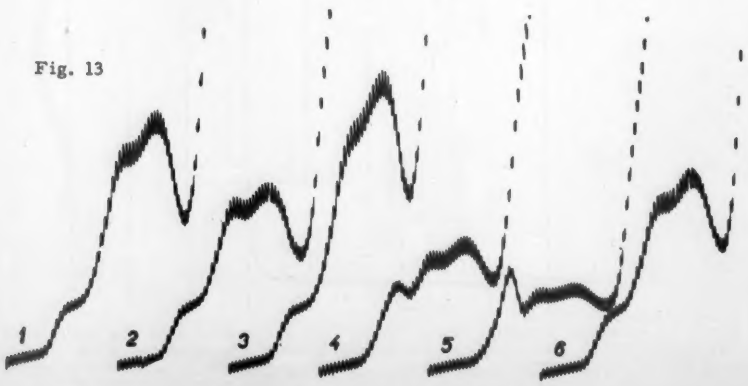


Fig. 12

Fig. 13



volt, and ordinarily is regarded as negligible. However, the charging current plays an important role in oscillographic polarography, where it is considerably greater. At a certain potential an electrolytic process starts—reduction or oxidation—which is shown by the passage of the current due to electrolysis. In the simplest case, molecules or ions of the reducible or oxidizable substances interchange electrons with the electrode and thereby are removed from the electrode surface. Then new molecules of the electroactive substance —the depolarizer—diffuse from the interior of the solution to the surface of the electrode. Ilkovič (*2*) has calculated the current governed by diffusion to the surface of the expanding drop, deducing (in 1933) the formula of the "diffusion current":

$$i_d = 0.627\, nF \cdot D^{\frac{1}{2}} \cdot m^{\frac{2}{3}} \cdot t^{\frac{1}{6}} \cdot C$$

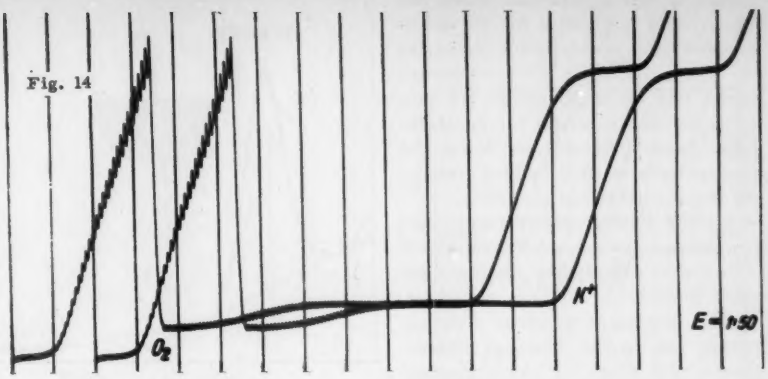
where n is the number of electrons involved in the reaction; F, the charge of Faraday; D, the diffusion constant; m, the rate of flow of mercury through the capillary; t, the drop time; and C, the concentration. This is the most exact electrochemical law announced since Faraday's laws in 1833. When corrected for spherical diffusion according to the method of Koutecky (*3*), the agreement with experimental results is completed. Figure 6 gives the reproducibility of a polarogram, showing the diffusion current due to atmospheric oxygen in an alkaline solution.

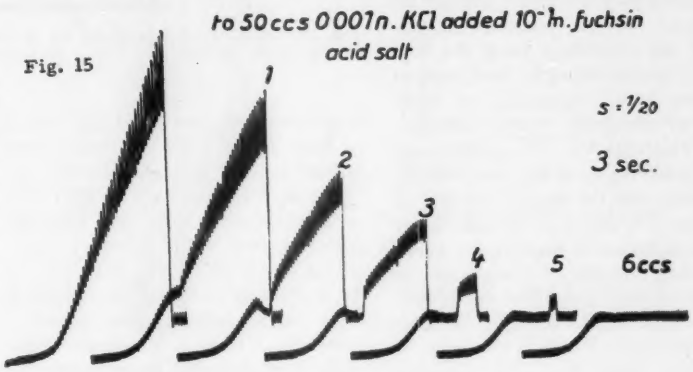
From this law the equations for the current-voltage curves due to the reductions and oxidations of depolarizers were deduced, and from these equations the rule of constancy of the half-wave potentials $E_{\frac{1}{2}}$ follows (*4*). These values introduced new electrochemical constants (Figs. 7, 8), which have thermodynamic significance in that they give affinities of electrode reactions. Also, constants of complexes can be derived from such equations (*5*) (Fig. 9).

In 1943 Wiesner (*6*) discovered currents of another sort, controlled by the rate of the chemical reaction yielding

Fig. 10. Kinetic currents of glucose at various temperatures. Fig. 11. Polarographic reduction waves of phenylglyoxylic acid in buffer solutions of various *p*H. Fig. 12. The effect of proteins in ammoniacal solutions without and with cobalt. Fig. 13. Brdička's test with blood sera of various pathological states: (i) feverish state; (ii) hepatic tumor, suspected; (iii) stomach cancer, suspected; (iv) normal serum; (v) hepatic cirrhosis; (vi) arteriosclerosis.

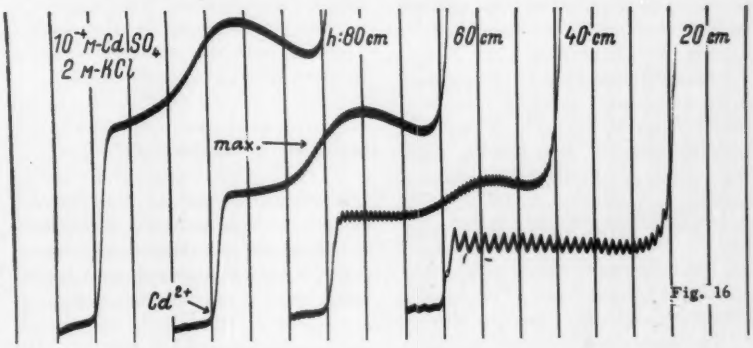
the depolarizer at the electrode. For example, formaldehyde or glucose give at ordinary temperature much smaller waves than would be expected from the Ilkovič formula (Fig. 10). Evidently a slower process than diffusion furnishes the depolarizer. In the case of formaldehyde, the molecules of methylene glycol $H_2C(OH)_2$ (*7*) have to be dehydrated to form the actual depolarizer, which is H_2CO. The current is governed by the rate of the dehydration, which of course depends on the *p*H. Such currents are termed "kinetic"; they make it possible to measure the rates of fast chemical reactions. Wiesner and Los (*8*) obtained from the currents due to glucose the kinetic constants of mutarotation and calculated the amount of the free aldehyde in 0.655*M* glucose at 25°C as 0.0030 percent. From the height of the two waves which appear in the reduction of a reducible acid, we are able to calculate the very high rates of the recombination of the ions with kinetic constants of the order of 10^7 to 10^{11} (Fig. 11).





Current Due to Catalytic Processes; Phenomenon of Maxima

In comparison with the kinetic currents, the polarographic currents due to catalytic processes in the evolution of hydrogen, especially those due to —SH groups, are very much higher. For example, cystine and proteins in NH_3 buffers containing cobalt ions give a "catalytic" wave as cystine without the catalyst 500 to 700 times higher. Of these reactions the most noteworthy is the serological reaction of Brdička (*9*) (Fig. 12), to which many publications relate. This is characterized by the "protein double wave" (Fig. 13), which has been found to depend on the pathological state of the patient. All inflammations cause an increase of the protein wave. In the nonfeverish state it is cancer which is invariably manifested by an elevated protein wave. After the removal of the cancerous center, the reaction becomes normal; metastases



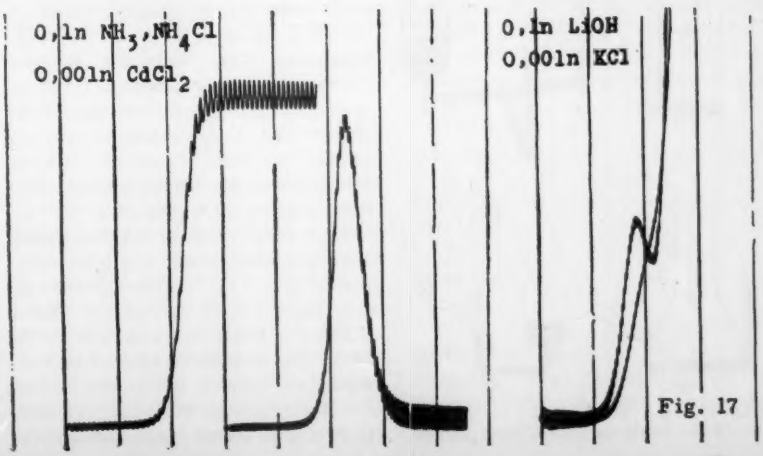


Fig. 14. Maximum of the first order on the wave of oxygen in 0.001*M* KCl. Fig. 15. Suppression of the maximum by a solution of fuchsin acid salt. Fig. 16. Maximum of the second order due to $CdSO_4$ in 2*M* KCl, showing influence of increasing the rate of flow of mercury. Fig. 17. Primitive and derivative polarographic curves: (left) $CdCl_2$ in ammonia buffer solution; (right) 0.001*M* KCl in 0.1*M* LiOH.

elevate it. It has been ascertained that the proteins responsible for the cancer reaction are mucoproteins belonging to the γ_2-globulins. Electrophoresis shows that the mucoproteins are akin to the serum component MP-2. On the other hand, liver diseases lower the protein wave, so that in liver troubles the polarographic test is specific.

Another type of polarographic current-voltage curves, closely connected with Kučera's anomalous maximum on the electrocapillary curve, are sharp maxima of current, which at a certain voltage fall to the limiting diffusion current (*10*) (Fig. 14). An inspection of the dropping electrode through the microscope reveals vehement streaming of the electrolyte along the lines of force to the electrode. Such maxima are very easily suppressed by slight traces of adsorbable matter, like fatty acids, dyestuffs (Fig. 15), gelatin, and other colloids, and in this way indicate very sensitively the degree of purity of solutions. The practical applications of the phenomenon of maxima are manifold. They are termed maxima of the first order when formed in dilute electrolytes (Fig. 16). In concentrated solutions there appear rounded maxima of the second order, due to the adhesion of the solution to the moving mercury surface; they are also suppressed by colloids like gelatin (Fig. 17).

I have referred only to the polarography of aqueous solutions. However, similar types of curves and electrode reactions may be followed in many nonaqueous conducting solutions—for example, in acetonitrile, dioxane, alcohols, glacial acetic acid, sulfuric acid, liquid ammonia, and fused salts. In all of them Ilkovič's law has been found to hold good at all temperatures.

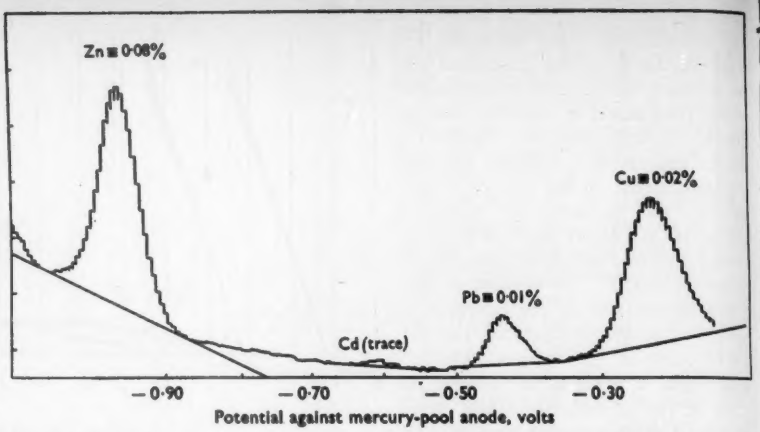


Fig. 19. Square-wave polarogram of an analysis of aluminum alloy: 200 mg of sample in 100 ml of 1*M* KCl.

The current-voltage curves are reproducible enough to yield with sufficient exactness even their derivative curve $(di/dE) - E$ (Fig. 18) (*11*). Since at the half-wave potential the ordinary curve has an inflection, the derivative curve shows there a maximum whose height is proportional to the concentration of the depolarizer. The potential of the maximum indicates the quality. There are several methods of obtaining the derivative curve automatically.

Sensitivity of the Method

The sensitivity of the polarographic method is high, showing depolarizers in a $5 \times 10^{-6}M$ concentration even in 0.1 cubic centimeter and, in a special vessel, even in 0.005 cubic millimeter, in which 5×10^{-11} gram of a depolarizer may be ascertained (Fig. 19). The most sensitive test is that of ruthenium, which is shown in a $5 \times 10^{-10}M$ concentration (*12*). With the Barker's "square wave polarograph" (*13*), where the charging current is practically eliminated and the electrolytic one is strongly amplified, curves of a derivative character are obtained which show 10^{-8} mole per liter (Fig. 20).

Most sensitive of all is polarography combined with measurement of radioactivity (Fig. 21) (*14*). The method consists in measuring the activity of the β and γ radiation of mercury drops on which the radioactive metal has been deposited. Isotopes, of course, cannot be distinguished, but, for example, from a mixture of radioactive zirconium-95 and niobium-95, the daughter substance, zirconium-95, can be separated, because it is deposited at the electrode, whereas niobium remains in solution. This radioactive technique promises wide applications through enabling one not only to carry out quick, accurate analyses and separations of radionuclides but also to learn the basic electrochemistry of very dilute solutions and electrode reactions. The sensitivity is that of radioactive methods.

All the afore-mentioned polarographic methods are used for analytical determinations, qualitative and quantitative, in microdoses as well as macrodoses of inorganic or organic depolarizers. If the substance to be determined is not a depolarizer it may be chemically converted into a depolarizer and so determined. For example, benzene is no depolarizer, its traces in air are noxious, and microdetermination is de-

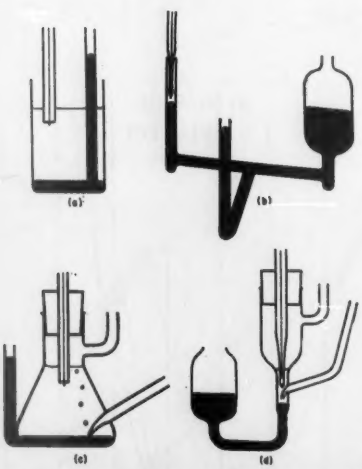


Fig. 18. Polarographic cells for standard (*a*, *c*) and micro (*b*, *d*) analysis.

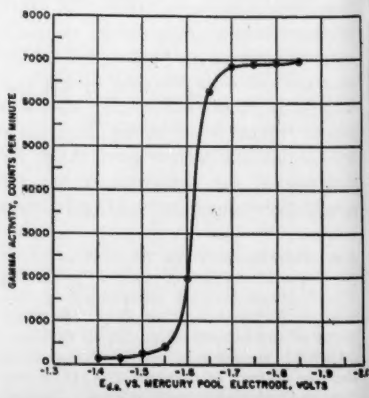


Fig. 20. Plotting of radioactivity of mercury drops against the applied potential.

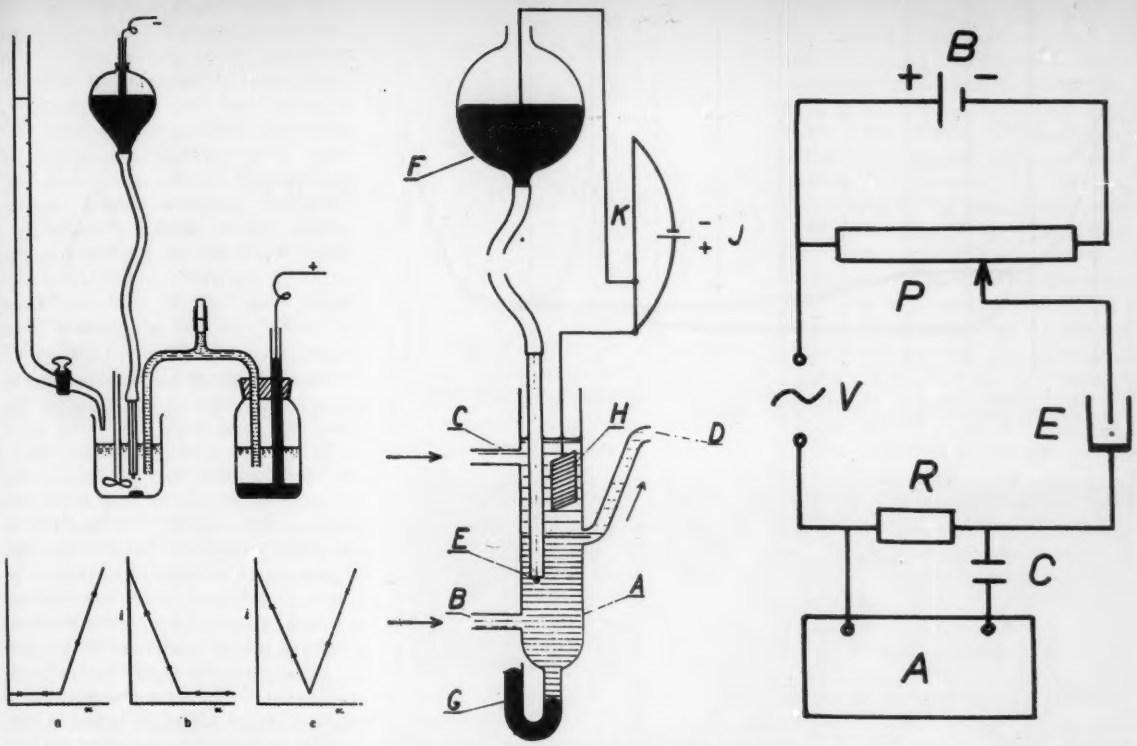


Fig. 21 (left). Limiting current titrations, arrangement and diagrams. (*a*) Lead salt in burette, sulfuric acid in beaker; (*b*) sulfuric acid in burette, lead salt in beaker; (c) lead salt in beaker. Fig. 22 (middle). Scheme of a continuous polarographic analyzer. (*E*) Indicating electrode; (*H*) redox electrode of constant potential; (*B*) inlet of solution to be analyzed; (*C*) inlet of redox mixture. Fig. 23 (right). Circuit of Breyer's alternating-current polarography. (*B*) Lead accumulator; (*P*) potentiometer; (*V*) alternating voltage; (*R*) ohmic resistance; (*C*) condenser; (*A*) voltmeter for alternating voltage.

sired. The smallest traces of benzene are easily converted by nitration into nitrobenzene and, after alkalization, exactly determined in respiration, in blood, or in urine.

Related Methods

A new trend in volumetric analysis was introduced in 1926 by polarographic titrations (*15*), later called "polarometric" by Majer (*16*) and "amperometric" by Kolthoff (*17*), which use the limiting current to indicate the end point. The indicating electrode may be, instead of the dropping electrode, a rotating or vibrating electrode of solid metal. The accuracy of the polarographic titration here reaches 0.3 percent. For the titration graph, two readings of the current before and two after the equivalent point suffice. The method does not require a "polarograph"; a potentiometer and a galvanometer of less sensitivity suffice (Fig. 22).

On the basis of experience with the "polarograph," special continuous polarographic analyzers have been constructed which follow for many weeks without interruption the content of solutions flowing through the cell (Fig. 23). These analyzers are used for the automatic control and regulation of technical processes in industry, for recording the presence in the atmosphere of noxious gases such as SO_2, HCN, and CO, and for other purposes.

Breyer and his co-workers (*19*) introduced in 1944 the "tensammetric" method, which uses the dropping-mercury arrangement by applying a slowly increasing voltage with superposed alternating voltage (Fig. 24) of some 10 to 30 millivolts and 50 hertz frequency. The alternating current which passes through the polarographic cell is measured, and the current-voltage curve is recorded. The method resembles the method from which it is derived inasmuch as it gives peaks at the half-wave potentials of reversible depolarizers, but it is very sensitive to adsorbable substances which change the surface tension of the mercury electrode (Fig. 25)—hence the name *tensammetry*. The changes in capacity due to adsorption produce, on the current-voltage curves, peaks often 100 times higher than the normal height of the wave of the organic compound. The chief advantage of Breyer's tensammetric method is that it can determine with high sensitivity many organic substances which are polarographically inactive, provided they are surface-active.

A great field that has opened since 1938 is "oscillographic polarography" (*20*), which substitutes the cathode-ray oscillograph for the galvanometer and voltmeter (Fig. 26). This brings the velocity of recording a polarographic curve to 1/50 second, and the accuracy of analytical determinations is about the same as in classical polarography.

Significance

We often hear it said that polarography did not bring anything new into chemistry except an improvement in analytical methods. That is decidedly not so, since in the study of reductions

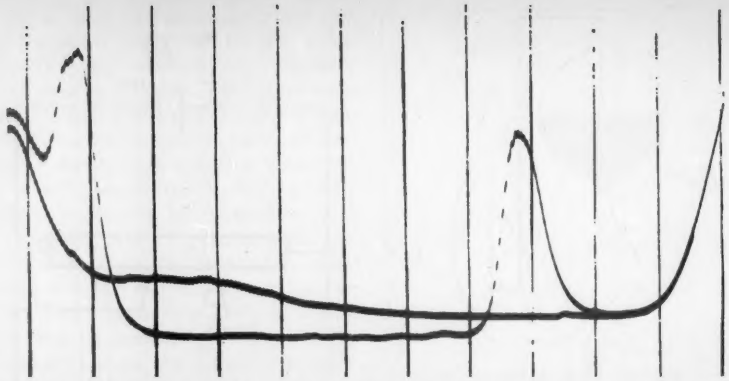


Fig. 24. Tensammetric maxima due to adsorption and desorption of cyclohexanol in acetate buffer solution. (Upper curve) pure solution.

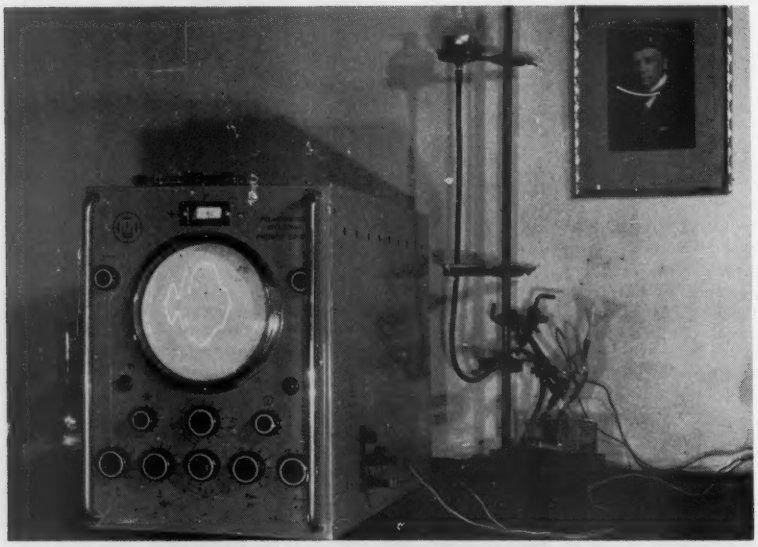


Fig. 25. Oscilloscope for polarographic analysis.

Fig. 26. Oscillographic diagram $dE/dt = f(E)$ of *o*- and *m*-nitrophenol, apart and in mixture.

or oxidations many otherwise inaccessible physicochemical constants are determinable. Polarography helps in the investigation of the chemical structure of organic, and lately even of inorganic, compounds. Striking are the results arrived at by polarographic studies of complexes of cobalt, nickel, iron, and chromium—complexes whose current-voltage curves disclose strange valencies. Vlček proved, for example, that cobalt in dipyridyl complexes is reduced from Co^{III} to Co^{II}, and from Co^{II} to Co^{I} (*21*), and as a result of these studies succeeded in preparing monovalent Co (dipyridyl)$_3^{I}$ complex. He also proved from polarographic curves the complex compounds of zero-valent nickel and cobalt, and in the carbonyls, negatively divalent iron and cobalt. The Cr^{III} tripyridyl complex may be successively reduced to Cr^{II}, Cr^{I}, and Cr^{0} in three equal steps. So far it is the only known instance in electrochemistry in which a trivalent cation can acquire, three times, one electron after another.

Although the analytical application of polarography is highly advanced at present, the field of its utilization in basic chemical problems is just beginning to open.

References

1. J. Heyrovsky and M. Shikata, *Rec. trav. chim.* **44**, 496 (1925).
2. D. Ilkovič, *Collection Czechoslovak Chem. Commun.* **6**, 498 (1934); *J. chim. phys.* **35**, 129 (1938).
3. J. Koutecky, *Czechoslov. J. Phys.* **2**, 50 (1953).
4. J. Heyrovsky and D. Ilkovič, *Collection Czechoslovak Chem. Commun.* **7**, 198 (1935).
5. J. Heyrovsky, *Trans. Faraday Soc.* **19**, 692 (1924); J. Koryta, *Chem. Tech.* **7**, 464 (1955).
6. K. Wiesner, *Z. Elektrochem.* **49**, 164 (1943).
7. R. Brdička, *Collection Czechoslovak Chem. Commun.* **20**, 387 (1955).
8. J. M. Los, L. B. Simpson, K. Wiesner, *J. Am. Chem. Soc.* **78**, 1564 (1956).
9. R. Brdička, *Collection Czechoslovak Chem. Commun.* **5**, 112 (1933); *Z. physik Chem. (Leipzig)*, special issue, 165 (July 1958).
10. M. von Stackelberg, *Fortschr. chem. Forsch.* **2**, 229 (1951); J. Heyrovsky, *Z. physik. Chem. (Leipzig)*, special issue, 7 (July 1958).
11. J. Vogel and J. Říha, *J. Chim. phys.* **47**, 5 (1950).
12. M. A. El Guebely, *ibid.* **53**, 753 (1956).
13. G. C. Barker and I. L. Jenkins, *Analyst* **77**, 685 (1952).
14. D. L. Love, *Anal. Chim. Acta* **18**, 72 (1958).
15. J. Heyrovsky and S. Berezicky, *Collection Czechoslovak Chem. Commun.* **1**, 19 (1929).
16. V. Majer, *Z. Elektrochem.* **42**, 123 (1936).
17. I. M. Kolthoff and Y. D. Pan, *J. Am. Chem. Soc.* **61**, 3402 (1939).
18. J. A. V. Novák, *Acta chim. Acad. Sci. Hung.* **9**, 37 (1956).
19. B. Breyer, F. Gutmann, H. H. Bauer, *Österr. Chemiker-Ztg.* **57**, 67 (1956).
20. J. W. Loveland and P. J. Elving, *Chem. Revs.* **51**, 67 (1952); J. Heyrovsky and R. Kalvoda, *Oszillographische Polarographie* (Akademieverlag, Berlin, 1959).
21. A. A. Vlček, *Nature* **177**, 1043 (1956); *ibid.* **180**, 753 (1957).

Science in the News

"Health for Peace" Bill: It Encourages But Cannot Require the Administration To Take Action

The widely supported "Health for Peace" Act was signed by the President last week, after the Senate accepted the House's watered-down version of the bill just before the congressional recess. The effect of the legislation is going to depend very much on how the present Administration and the new one that will take over in January choose to act on it.

The act does not, either in the version which passed or in the more elaborate version endorsed earlier by the Senate, give the Administration any powers it did not already have. It specifically authorizes the President and the Public Health Service to give grants to foreign scientists and institutions. Although legislation already in force could be interpreted as granting this power, the Health for Peace Act makes it perfectly clear both that the Administration has this power and that it is the intent of Congress that money should be spent for overseas grants. The area in which this specific authority could be most important is in making grants for research in areas which present a health problem primarily to foreign nations. Without this legislation questions could have been raised if a grant were made, for example, to an African institution for research on sleeping sickness. A congressional appropriation committee might conceivably have refused to provide money for such work. The Health for Peace Act makes it clear that Congress would like to see some money spent in this way.

"Science for Peace" Proposal

The original impetus for the proposal came from President Eisenhower's 1958 State of the Union message. Eisenhower talked of the United States taking the lead in an international "science for peace" movement. Senator Hill of Alabama then introduced a generally worded bill to serve as the basis for hearings which he hoped would lead to the passage of legislation embodying some specific proposals. Early in the following session, in February 1959, Hill was joined by 58 other senators in sponsoring the Health for Peace Bill. It provided for setting up an Institute of International Health as a separate division within the National Institutes of Health, stated the intent of Congress that grants be made to promote world health, and authorized an appropriation of $50 million a year to support the program.

Budget Bureau Objects

With more than half the Senate listed as co-sponsors, the bill, of course, passed easily. The major opposition was not to the general intent of the bill but to its terms, to which the Administration objected. The Budget Bureau objected to the provision setting up an Institute of International Health on the grounds that Congress should let the executive branch work out its own administrative methods and not insist on a specific type of organization. It objected to the $50 million authorization on the grounds that this would seem to foreign countries to be a commitment to spend that much money each year—a specific commitment the Administration preferred not to have written into the law, and which, in any case, could not be met unless Congress provided the money in the yearly appropriation bills. The Bureau also objected to provisions granting the powers directly to the Public Health Service rather than to the President. The Bureau felt that the authority for promoting the health of foreign nations should be considered part of the foreign assistance programs and that this made it a subject of direct interest to the State Department, to ICA, and to the President.

The bill, after passing the Senate, early in 1959, went to the House Commerce Committee, which through historical accident happens to have jurisdiction over matters relating to the Public Health Service. There was considerably less sympathy for the plan here than there had been in the Senate Labor and Public Welfare Committee. Three weeks ago the House committee completed its leisurely deliberations and reported a substitute bill which met the Administration's objections. The Senate accepted the House bill, since it was apparent that no important concessions could be expected from the House if the Senate insisted on its own bill and asked for a conference to resolve the differences. In any case it was fairly clear that the Administration had a good case in asking for the changes it did. Sources close to Senator Hill concede that the President could properly insist on having direct jurisdiction over the part of the program that is aimed at helping foreign countries solve their special health problems, and they concede that the provision requiring a new organization to administer the program and the specific authorization of $50 million were not necessary for carrying out the program but only provisions designed to help push a possibly reluctant Administration into taking some action.

Role of NIH

Under the bill as passed, the grants will be made by the National Institutes of Health, under the procedures used to give grants to American applicants. To some extent this has already been done. Last year a little less than $4 million out of the $200 million in grants awarded by the National Institutes of Health went to foreign scientists, although only for work of direct importance to major American health problems. The NIH also supported 130-odd Americans working on fellowships overseas and some 80 foreign students on fellowships in this country. It also is supporting about 130 visiting scientists working in this country. The total for such NIH international health activities last year came to about $8 million.

There are also a few projects under way of the type contemplated under the foreign assistance provisions of the Health for Peace Act. Some work is being done in Panama and the Canal Zone on tropical diseases, and a $300,000 research project on cholera is being carried on in Pakistan with foreign aid

funds provided by the International Cooperation Administration and administered, at ICA's request, by the NIH.

All of this demonstrates that the Administration was able to do exactly the sort of work the Health for Peace Act authorizes even before the act was passed. How much such projects will be expanded now that Congress has expressed its formal intent that they be pushed is a matter that is in the hands of the Administration. So far there is not much indication that the Administration intends to respond to the new Act with a rapid expansion of its international health activities. This does not mean that Senator Hill and other Congressmen and private individuals and organizations that have worked for this legislation have been wasting their time. It does mean that the many people who have supported Health for Peace are misleading themselves if they think the fact that the proposal has been formally passed into law means that results are going to be automatically forthcoming.

Color Additives Act Passed

Congress has passed and the President has signed the final version of the color additives amendment to the Pure Food Act. It specifies the conditions of safety an additive must meet before it can be used in or on a product that comes into contact with the mouth. The Senate accepted the "Delaney clause" (*Science*, 10 June) inserted by the House. This flatly outlaws the use of any material that has been shown to cause cancer in animals or man, no matter how wide the difference between the amount that could cause cancer and the amount which might be ingested through the use of the substance in a color additive.

Federal Funds for Science

The final budget for medical research will not be set until the extra session of Congress convenes in August, but other major appropriations for scientific research and development have been cleared, and they show federal support for science climbing to a new peak, as it has every year since 1950. The exact totals will be compiled by the National Science Foundation for a report it plans to issue in November, but the rough total of money to be spent or committed in the fiscal year is known. It will be in the neighborhood of $9 billion, which is a good deal more than the total for R & D financed by industry and the universities and foundations.

A breakdown is expected to show that about $2 billion of the roughly $9 billion for R & D will be spent on research proper, as opposed to development. Between $600 and $700 million of this will be spent on basic as opposed to applied research—that is, for research not directed towards a specific practical application. About two-thirds of the research money will be spent on the physical sciences, one-third on the life sciences, a small fraction (roughly 3 percent) on the social sciences. About half of the basic research and one-sixth of the applied research is financed through grants to universities.—H.M.

News Notes

AAAS-Westinghouse Science Writing Competition Announced

The nation's newspaper and magazine writers are invited to enter the 1960 AAAS-Westinghouse Science Writing Awards competition, which annually offers two $1000 prizes, one for magazine writing and one for newspaper writing. The AAAS administers the program, and the presentations will be made at the annual dinner of the National Association of Science Writers on 27 December 1960, during the winter meeting of the AAAS in New York City.

A board of six judges prominent in the fields of journalism, science, and public affairs will select the winners. Articles on the natural sciences and their engineering and technological applications (medicine is excluded) will be considered.

The AAAS-Westinghouse Awards were established to recognize and encourage outstanding popular science writing, to stimulate public interest in science, and to foster a deeper understanding of the significance of science on the part of the general public. The program is supported by the Westinghouse Electric Corporation through a grant from the Westinghouse Educational Foundation.

Last year's newspaper award was won by Victor Cohn of the Minneapolis *Tribune* for his series "Year of the Sputnik," which dealt with the state of Russian science. Francis Bello won the magazine award for his article "An Astonishing New Theory of Color," which appeared in the May 1959 issue of *Fortune*.

Conditions

To be considered for the 1960 awards, a magazine article or a newspaper or press association report must have appeared in the United States between 1 October 1959 and 30 September 1960. Either a single article or a series of articles may be submitted. However, work published in trade journals or professional scientific magazines is not eligible.

The entries will be judged on the basis of initiative, originality, scientific accuracy, clarity of interpretation, and value in promoting a better understanding of science by the lay public. All those engaged in popular science writing, irrespective of their professional employment, are invited to participate in this year's competition.

Each entrant may submit for consideration as many as three separate articles published during the contest year. Persons other than the author may nominate entries in accordance with the rules; the deadline for all entries is *10 October 1960*.

In addition to cash awards for the authors, citations will be presented to the newspaper and magazine in which the winning articles appeared. Also, at the discretion of the judges, honorable mention citations or other special recognition for distinguished service to science journalism may be made.

Entry blanks, rules, and information concerning the competition can be obtained by writing: Dr. Graham DuShane, AAAS, 1515 Massachusetts Ave., NW, Washington 5, D.C.

Grant for Astrograph in Southern Hemisphere

The Ford Foundation has allocated $750,000 to construct an astrograph—a telescope for measuring precisely the motion of stars in our galaxy—in the Southern Hemisphere. The new star camera will measure the position and speed of stars in the third of the sky not covered by the only such astrograph now in existence, located at Lick Observatory, Mt. Hamilton, Calif.

The grant was made to Yale University, which will operate the new astrograph jointly with Columbia University. Dirk Brouwer of Yale and Jan Schilt

of Columbia will direct the program. Yale is surveying possible sites in Argentina and Chile; the instrument is scheduled to go into operation in 1962.

The astrograph differs from other great modern telescopes in that it is designed for maximum area of sky coverage with minimum distortion rather than for maximum light-gathering power. Most of the stars in our galaxy are seen best from the Southern Hemisphere. The new astrograph will increase the value of data obtained by the Lick astrograph because the two cameras will overlap in a third of the sky, permitting correlation of data from the two instruments.

Other Ford Foundation Grants

A grant of $16,000 was made to the American Society of Engineering Education for a survey of the attitudes toward academic careers of members of Tau Beta Pi, engineering honor fraternity.

The Brooklyn Polytechnic Institute was given $700,000 to help establish an honors program leading to the doctorate in engineering and the sciences.

The foundation granted $2.5 million to Princeton University and $3.4 million to Stanford University to support an expanded doctoral program in engineering.

Atmospheric Research Group

A $500,000 National Science Foundation contract with the University Corporation on Atmospheric Research will assist in establishing a national center on atmospheric research. The center will consist of a central scientific group to stimulate and supplement university research and to provide facility management for what will probably become a large research effort. Walter Orr Roberts, director of the High Altitude Observatory, Boulder, Colo., since its inception in 1940, has been named director of the group.

Research programs of the center are expected to fall into the following categories: (i) atmospheric motions, (ii) energy exchange processes in the atmosphere, (iii) water substance in the atmosphere, and (iv) physical phenomena in the atmosphere. During the coming year, Roberts will select a senior scientific staff of eight or more individuals; will rent office, laboratory, and shop facilities; and will plan a research program, with his staff and other scientists. Because of the multidisciplinary character of atmospheric research, the staff is expected to be composed of scientists from various fields, including physics, chemistry, meteorology, and engineering.

Early Hindu Texts Translated and Published

Publication of an important series, "Hindu Astronomical and Mathematical Texts," has recently been undertaken by the department of mathematics and astronomy at Lucknow University under the general supervision of Ram Ballabh. The first number in the series—the *Sūrya-siddhānta*, one of the earliest works on Hindu astronomy—appeared in 1957, and the second number has just come out. It is the *Patiganita* of Sridharacarya (8th century A.D.) in the Sanscrit original and with an English translation, introduction, and notes.

The objective in publishing the series is to bring out authoritative editions of important unpublished works dealing with ancient Indian astronomy and mathematics. The works of Bhaskara I of the 6th and 7th centuries A.D. are in press and will appear shortly as Nos. 3 to 6 of the series. Publications of this kind (text editions with translations) are exactly what is needed for studying the history of ancient science.

The exact date of composition of the *Sūrya-siddhānta* is not known. There is reason to believe that it was written before 966 and after 628 A.D. It is an accomplished work on Hindu astronomy and was without doubt based upon an older *siddhānta*. It consists of 14 chapters, of which the first 11 deal with astronomical computations and the remaining three, with cosmogony and geography, astronomical instruments, and time reckoning. In view of our present-day ideas regarding the age of the universe, it may be of interest to point out that the *Sūrya-siddhānta* supposes that the creator Brahma spent 17,164,000 solar years in the creation of the world, and that when the task was over, all the planets and the apogees and ascending nodes of their orbits were in the same straight line. This "time of creation of the world" was apparently computed to have been 1,955,883,257 years before the birth of Christ.

Sridharacarya's *Patiganita* was intended to provide a complete course of arithmetic and mensuration to meet the needs of students and businessmen. It treats addition, substraction, multiplication, division, squares, square roots, cubes, cube roots, operations with fractions, the rule of three, the inverse rule of three, the rule of five, the rule of seven, the rule of nine, barter of commodities, simple interest, partnership, purchase and sale, meeting of two travelers, wages and payments, the well-known cistern problem, and certain special problems that reduce to the solution of simple and quadratic equations. It deals with arithmetic and geometric series as well as with series of squares and cubes and with successive sums of series in arithmetic progression. The rule given for finding the time in which a sum lent out at simple interest will be paid back in equal monthly installments and the rule telling how two travelers starting at different times with different speeds and accelerations would meet twice on their journey are perhaps of special interest as being Sridharacarya's own invention.

E. C. WATSON

American Embassy,
New Delhi, India

AAAS Theobald Smith Award in the Medical Sciences

The Theobald Smith Award of $1000 and a bronze medal, which has been given yearly since 1937 (except for a lapse during the war years) by Eli Lilly and Company of Indianapolis, under the auspices of the American Association for the Advancement of Science, will be presented at the association's 127th meeting in New York, 26–31 December. Travel expenses will be paid by the donors to enable the recipient to receive the award in person.

Nominations are now being requested for the award. They may be made by fellows of the AAAS and should be sent to the secretary of the Section of Medical Sciences, Dr. Allan D. Bass, Department of Pharmacology, Vanderbilt University School of Medicine, Nashville 5, Tenn.

The prize is given for "demonstrated research in the field of the medical sciences, taking into consideration independence of thought and originality." Any investigator who was less than 35 years of age on 1 January 1960 and is a citizen of the United States is eligible. The research is not to be judged in

comparison with the work of more mature and experienced investigators.

Nominations must be received before 1 September. All nominations should be accompanied by: (i) six copies of a two-page summary in the form of a letter of nomination which details the importance of the candidate's work; (ii) six copies of any manuscripts ready for publication; (iii) six copies each of reprints of the candidate's more important published articles; and (iv) six copies of a biographical sketch of the candidate.

The committee of judges consists of William B. Bean, department of internal medicine, University Hospitals, State University of Iowa; Arthur C. Guyton, chairman, department of physiology and biophysics, University of Mississippi Medical Center; C. Walton Lillehei, professor of surgery, University of Minnesota Medical School; and Arnold D. Welch, department of pharmacology, Yale University School of Medicine. Carl F. Schmidt, University of Pennsylvania School of Medicine, chairman of AAAS section N (Medical Sciences), is chairman, ex officio; Dr. Bass will serve as ex officio secretary.

Expenditures for Industrial Research and Development in 1958

American industry spent $8.2 billion on research and development in 1958, according to a report released by the National Science Foundation. This was a 7-percent increase over the figure for 1957 and more than double the level for 1953. Industry's $8.2 billion represents about three-fourths of the national expenditure for research and development in 1958, estimated at $11 billion.

These and other data are included in "Funds for Research and Development Performance in American Industry, 1958," report No. 20 of *Reviews of Data on Research & Development.* The report is based on a survey of industrial research and development conducted for the foundation by the Bureau of the Census.

Industrial research and development financed by the federal government in 1958 amounted to $4.6 billion, or 56 percent of the industry total and triple the comparable dollar figure for 1953. Increases in the amounts spent by the federal government in support of research and development in recent years have been mainly responsible for the significant annual increases in over-all industry totals.

The aircraft and parts and the electrical equipment and communication industries, which were heavily engaged in research and development financed by federal funds, accounted for more than half the $8.2 billion total. Industries ranking next in terms of expenditures on research and development were chemical and allied products, machinery, and motor vehicles and other transportation equipment. In terms of research and development financed wholly by company funds, the chemicals and allied products industry led all others in 1958.

The aircraft and parts industry, in which there had been relatively large increases in research and development activities from 1953 to 1957, reported a slight decline in 1958. Among the industries that reported substantial increases in their research and development expenditures in 1958 were electrical equipment and communication; drugs and medicines; motor vehicles and other transportation equipment; and optical, surgical, photographic, and other instruments.

Expenditures for basic research amounted to $296 million in private industry in 1958, or 4 percent of the total spent on industrial research and development. The leading industry in terms of dollar volume of basic research was the chemicals and allied products industry, which accounted for one-third of the total. Ranking next were the petroleum refining and extraction industry and the electrical equipment and communication industry.

Copies of the report are available from the Superintendent of Documents, GPO, Washington, D.C., for 10 cents.

Foreign Students and Faculty Members in U.S. Reach New High

The 48,486 foreign students and 2539 foreign faculty members in the United States during 1959–60 constituted the largest foreign academic population in the world, according to *Open Doors 1960*, the annual publication of the Institute of International Education.

Forty-five percent of the faculty members taught, or were engaged in research in, the natural sciences, while 15 percent of the students worked in this area. The fields of medical science, social science, engineering, and agriculture accounted for an additional 41 percent of the faculty members and 48 percent of the students.

The schools with the highest enrollments of foreign students were the University of California (1918); New York University (1580); the University of Minnesota (1156); and Columbia University (1146) The institutions with the most foreign faculty members were Massachusetts Institute of Technology (194); Yale University (131); and the University of California (131). The areas from which the largest numbers of foreign students came were the Far East, Latin America, and the Middle East, in that order. Students from these areas favored engineering.

Although the total number of foreign students in the United States was at an all-time high, the percentage increase was the smallest in 6 years. The rise from 1958 to 1959 was only 2.6 percent as compared with 8.8 percent for the previous period.

The number of American students going abroad to study, however, increased 34 percent from 1958 to 1959. In the past year, 13,651 students enrolled at 520 institutions in 62 countries. Better polling, the report explains, may account for a part of this apparent increase. France attracted 1832 American students; Canada, 1681; the United Kingdom, 1352. The number of U.S. faculty members abroad decreased from 1842 in 1958–59 to 1777 in 1959–60.

Biological Writing Conference

The first writing conference of the Biological Sciences Curriculum Study is meeting at the University of Colorado, Boulder, for 7 weeks this summer. The curriculum study, an activity of the American Institute of Biological Sciences, is supported by grants from the National Science Foundation.

Seventy high school and college teachers, together with a group of publication specialists, are preparing the texts and materials for three versions of a high school biology course. One version stresses the developmental approach, another the ecological, and the third the physiological.

Arnold B. Grobman, director of the study, says that a second writing conference will meet next summer after the three approaches have been tested in 105 schools during the coming year.

Science Pavilion for "Century 21" Exposition

A science pavilion will be the main feature of the United States Government's $9 million exhibit in the Century 21 International Exposition to be held in 1962 in Seattle.

The $3.5 million World of Science pavilion, a complex of five structures joined around a courtyard pool and fountains, with arching domes on the terrace entrance, will be comparable in size and scope to the American Pavilion at the 1958 Brussels World Fair. It will house the most extensive science exhibit ever assembled by the United States, to depict the role of science in modern civilization.

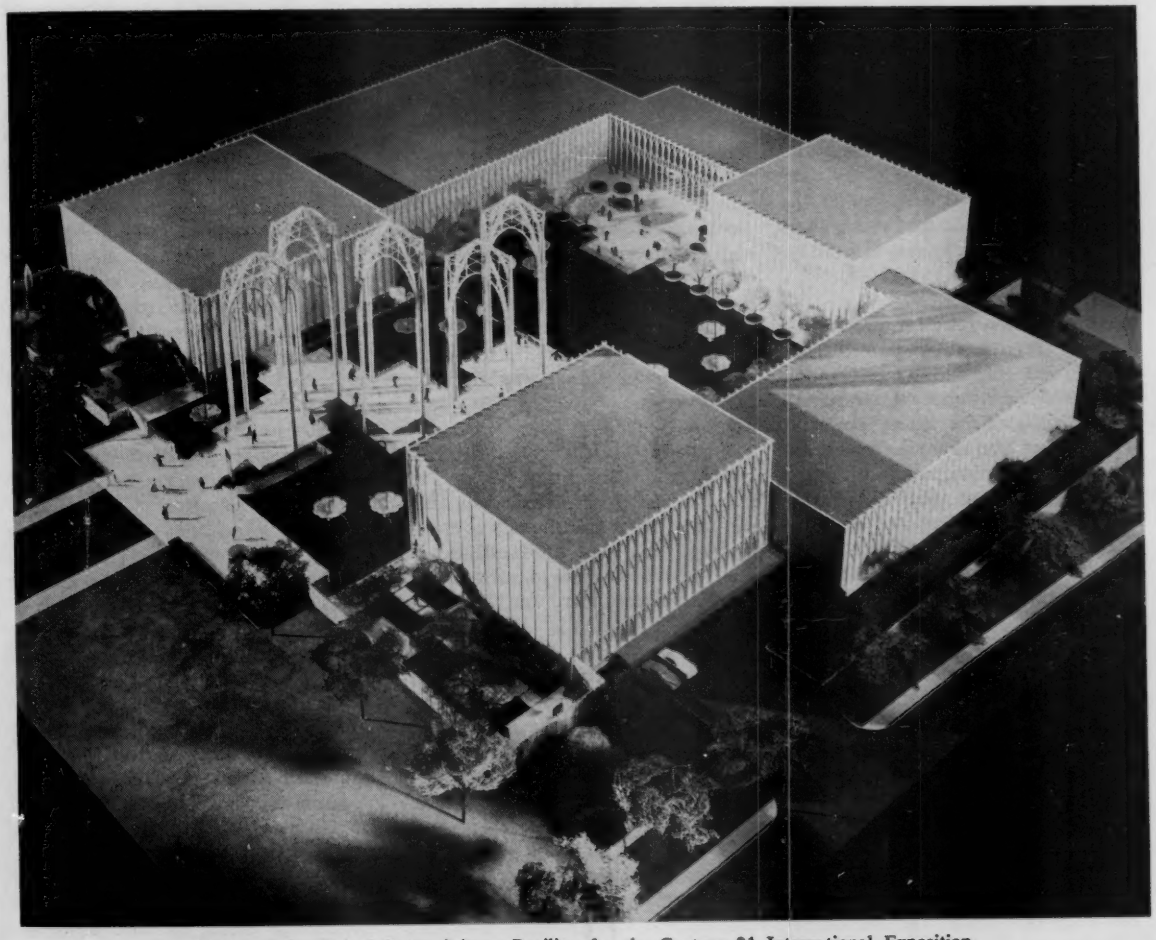
The pavilion is expected to be the dominant exhibit and the one which sets "Century 21" apart as a truly unique exposition. The $9 million to be spent by the United States represents the largest single appropriation ever made by Congress for a domestic exposition. The event itself is the first of its kind to be held in the United States since the San Francisco and New York World Fairs of 1939.

Foreign Lecturers Tour U.S.

Sixteen physical scientists, selected from 11 countries, opened an 8-week lecture tour of the United States with a 4-day conference at Temple University, Philadelphia, 28 June–1 July. This is the 2nd Visiting Foreign Staff Project of the National Science Foundation, a series begun last year to help improve science education in the U.S.

After the conference at Temple, the lecturers left for a series of one- or two-day visits at 100 summer institutes for science teachers; each visitor will lecture at approximately eight of these institutes. Six of the scientists will lecture at the summer institute of Temple, which will run until 19 August. The Temple Institute will be the only one of the institutes this year to present an advanced program of the Physical Science Study Committee.

Elmer L. Offenbacher, associate professor of physics at Temple, is director of the visiting scientists project. The 4-day briefing at Temple offered the lecturers an opportunity to test their talks before a representative group of teachers. In addition to criticism of their presentations and advice on teaching methods, the visitors were given briefings on the audiences they will face.



Model of the United States Science Pavilion for the Century 21 International Exposition.

Scientists in the News

The National Academy of Sciences has announced that four distinguished scientists abroad have been elected foreign associates, one of the highest honors that can be bestowed by the academy on a scientist who is not a citizen of the United States.

Edmond Antoine Brun, aeronautical engineer, professor, Ecole Nationale Supérieure de l'Aeronautique.

Sir **Cyril Norman Hinshelwood**, president of the Royal Society and professor of chemistry, Oxford University.

Lev Davidovich Landau, head of the theoretical section, Institute for Physical Problems of the Academy of Sciences of the U.S.S.R. and professor of physics, University of Moscow.

Luis F. Leloir, biochemist, research professor, Facultad de Ciencias Exactas y Naturales, University of Buenos Aires.

Brun is distinguished for his research in fluid dynamics and thermodynamics. Hinshelwood, who shared the Nobel Prize for chemistry in 1956, has won an international reputation for his research in thermodynamics and chemical kinetics. Landau's contributions as a theoretical physicist have been made in quantum mechanics and electrodynamics, magnetism, superfluidity, and parity. Leloir, a past president of the Argentine Association for the Advancement of Science, is known for his research in metabolism.

Two American scientists will receive honorary degrees from Oxford University on 21 July during a celebration of the 300th anniversary of England's Royal Society: **Felix Bloch**, professor of physics at Stanford University, and **Alfred N. Richards**, emeritus professor of pharmacology at the University of Pennsylvania.

Other scientists who will be honored by Oxford include **Nicolai N. Semenov** of the Institute of Chemical Physics at the Soviet Academy of Sciences; **Edgar W. R. Steacie**, president of the Research Council of Canada; and **Ojvind Winge** of the Carlsberg Laboratorium, Copenhagen.

President Eisenhower has approved the appointment of **Philip H. Abelson** as a member of the General Advisory Committee of the U.S. Atomic Energy Commission, effective immediately. Abelson is director of the Geophysical Laboratory of the Carnegie Institution of Washington, Washington, D.C.

Bernard M. Wagner, associate professor of pathology and Robert L. King professor for cardiovascular research at the University of Washington School of Medicine, has been named professor and chairman of the department of pathology at New York Medical College.

Robert B. Bennett, professor of chemical engineering at the University of Florida, will spend 2 years at the Universidade de Minas Gerais in Belo Horizonte, Brazil; he will teach chemical engineering and assist in organizing a chemical engineering laboratory and pilot plant.

Paul G. LeFevre, scientist in the physiology division of the Medical Research Center of Brookhaven National Laboratory, has become professor of pharmacology at the School of Medicine of the University of Louisville.

Dorothy M. Powelson, former associate professor of bacteriology at Purdue University, is now micro- and cellular biologist on the staff of the Stanford Research Institute, Menlo Park, Calif.

Friedrich F. Nord, professor of organic chemistry and enzymology at Fordham University since 1938, resigned at the end of June. In retirement, Nord will continue his research on lignin in his Rose Hill laboratory. Nord, who was born in Hungary and educated in Germany, is the founder of three scientific journals and the author of 360 papers.

Frank H. Connell, professor of parasitology at the University of Texas Postgraduate School of Medicine and clinical professor of parasitology at Baylor University College of Medicine, has been named assistant director of the China Medical Board of New York, Inc.

George P. Rosemond, a general surgeon known for his cancer surgery and chemotherapy studies, has been named professor and co-chairman of the department of surgery at the Temple University School of Medicine, Philadelphia.

Lester C. Mark, associate professor of anesthesiology at the College of Physicians and Surgeons of Columbia University, will spend 8 months at the Bispebjerg Hospital in Copenhagen working on studies of the effects of barbiturate poisoning on acid-base balance and kidney function.

Mahlon B. Hoagland, a biochemist credited with the discovery of amino acid-activating enzymes, has been named associate professor of bacteriology and immunology at Harvard University. Hoagland is currently assistant professor of medicine in the Harvard Medical School and at the Massachusetts General Hospital.

The following scientists retired from the faculty of the University of California, Berkeley, in June:

Margaret I. Beattie, professor of public health and director of public health laboratory courses.

Charles L. Camp, professor of paleontology and curator of amphibians and reptiles in the Museum of Paleontology.

Mary C. Jones, professor of education, lecturer in psychology, and research associate in the Institute of Human Development.

John B. Leighly, professor and chairman of the department of geography.

Austin H. MacCormick, professor of criminology and acting dean of the School of Criminology.

N. Wing Mah, associate professor of political science.

Knowles A. Ryerson, dean of the College of Agriculture and assistant director of the university's Agricultural Experiment Station.

R. Earl Storie, professor of soils and plant nutrition.

Otto Struve, professor of astronomy and former head of the department of astronomy and the Leuschner Observatory.

Two mathematicians have been named to the faculty of the College of Literature, Science, and the Arts of the University of Michigan.

Lamberto Cesari, who is on leave from Purdue University for work at the Mathematics Research Center of the University of Wisconsin, was named professor of mathematics at Michigan.

Leonard J. Savage, chairman of the department of statistics at the University of Chicago, was also appointed professor of mathematics at Michigan. Savage will have a half-time appointment in the Institute of Science and Technology during the next academic year.

Alan F. Guttmacher, clinical professor of obstetrics and gynecology at the Columbia University College of Medicine and director of the department of obstetrics and gynecology at Mt. Sinai Hospital, New York, has been named director of the Margaret Sanger Research Bureau of New York.

Lloyd A. Wood, director of the Office of Research Grants and Contracts of the National Aeronautics and Space Administration, has been named scientist for advanced technology in the Office of Program Planning and Evaluation at NASA. **Thomas L. K. Smull**, assistant chief of the grants and contracts office, will succeed Wood as director.

Ira Dyer, acoustics scientist with Bolt Beranek and Newman, received the biennial award of the Acoustical Society of America on 10 June. Dyer was cited for his work on jet engine noise analysis and noise-induced vibration in relation to missile performance.

Ralph P. Johnson, vice president and general manager of Ramo-Wooldridge, has been appointed vice president in charge of the electronics division of Thompson Ramo Wooldridge Inc.

Derrick T. Vail, professor of opthalmology and chairman of the department at Northwestern University Medical School, has been awarded the Lucien Howe Gold Medal of the American Opthalmological Society for his work as an editor, teacher, clinician, and surgeon for 35 years.

Enno Mandema, research associate in the department of medicine of the University of Illinois, has been named professor of medicine and head of the department at State University, Groningen, Netherlands.

R. E. Jentoft, of the California Research Corporation, has been named senior research chemist in the analytical and physical measurements section of the Richmond Laboratory.

Henry M. Stommel, physical oceanographer at the Woods Hole Oceanographic Institution, has been named professor of oceanography at Harvard University. Stommel is the author of the theory of ocean currents which explains the flow of warm streams in masses of colder water.

The following have been appointed to the National Science Board by President Eisenhower.

William O. Baker, vice president for research, Bell Telephone Laboratories, Murray Hill, N.J.

Rufus E. Clement, president, Atlanta University.

Conrad Elvehjem, president, University of Wisconsin.

William W. Rubey, geologist in charge, Division of Area Geology and Basic Sciences, U.S. Geological Survey.

Glenn T. Seaborg, chancellor, University of California, Berkeley.

Eric A. Walker, president, Pennsylvania State University.

Malcolm M. Willey, vice president for academic administration, University of Minnesota.

Clement and Willey will serve the remainder of terms which expire in 1962 and 1964, respectively; the others received full 6-year appointments.

Charles A. Thomas retired from the faculty of Pennsylvania State University as professor emeritus of entomology after 35 years of service, on 30 June. Thomas, who is known for his work on mushroom pests, is professor of economic entomology with the Pennsylvania Experiment Station.

Harrison M. Tietz retired from Pennsylvania as professor emeritus of anatomy and physiology after 34 years.

Recent Deaths

Walter Baade, Göttingen, Germany; 67; visiting professor of astronomy at Göttingen University; retired in 1958 after 27 years with the Mount Wilson and Palomar Observatories of the California Institute of Technology and the Carnegie Institution of Washington; renowned for observations that provided the basis for current theories of the evolution of stars and led to important corrections in the cosmic distance scale; 26 June.

Alberto C. Blanc, Rome, Italy; 53; professor of paleethnology at the University of Rome and director of its Institute of Paleethnology; honorary member of the Prehistoric Society of London; 4 July.

Edward C. Elliott, Lafayette, Ind.; 85; president emeritus of Purdue University, which he headed from 1922 to 1945; 16 June.

Raymond G. Fuller, Bar Harbor, Me.; 74; sociologist who was widely known for his work in the improvement of child labor conditions and in the promotion of mental health; 16 June.

Cruz A. Gallastegui, Spain; director, Mision Biologica de Galicia, Pontevedra, Spain; formerly a student at the Bussey Institution of Harvard University and assistant in genetics at the Connecticut Agricultural Experiment Station; 7 June.

Sol W. Ginsburg, New York, N.Y.; 60; psychiatrist and psychoanalyst who contributed significantly to research and to the development of new approaches to hospital and community mental-health services; associate professor of clinical psychiatry at the Long Island College of Medicine; 5 July.

James H. Graham, Madision, N.J.; 81; former dean of the College of Engineering at the University of Kentucky, Lexington; 24 June.

Herman E. Hayward, Riverside, Calif.; 68; director of the U.S. Salinity Laboratory in Riverside for the past 15 years and member of its staff for more than 20 years; former professor of botany at the University of Chicago; 31 May.

Frederick C. Leonard, Los Angeles, Calif.; 64; professor of astronomy at the University of California, Los Angeles, where he had taught since 1922; was organizer, first president, and for many years editor of the publications of the Meteoritical Society; 23 June.

Warren Moore, Raphine, Va.; 67; retired consulting entomologist; specialist in insecticides, insect nutrition, and insect repellents; 11 June.

Martin J. Pollak, La Jolla, Calif.; 44; senior scientist with the Inter-American Tropical Tuna Commission; research associate of the Scripps Institution of Oceanography; 5 June.

Hubert G. Schenck, Palo Alto, Calif.; 62; paleontologist; professor of geology at Stanford University; former chief of the Mutual Security Administration Commission; 19 June.

Charles Singer, London, England; 84; historian of science and professor emeritus, University of London.

Lloyd E. Thomas, Portland, Ore.; 56; biochemist at Good Samaritan Hospital, Portland; formerly on the staff of the Medical School of the University of Missouri; 13 June.

George Urdang, Madison, Wis.; 78; historian of pharmacy; retired as the University of Wisconsin's first full professor in the history of pharmacy; former director of the American Institute of Pharmacy; 27 June.

Book Reviews

The American Voter. Angus Campbell, Philip E. Converse, Warren E. Miller, and Donald E. Stokes. Wiley, New York, 1960. 573 pp. $8.50.

Among the important differences between the social sciences and the natural sciences has been the general backwardness of the former in developing instruments for objective reporting, analysis, and validation of observations. Nothing comparable to the telescope, the thermometer, the barometer, or the microscope has been available to the economist, sociologist, psychologist, or political scientist. Nor have social scientists been able to make very extensive use of the controlled experiment in their research. If this generation of social or behavioral scientists has seemed inordinately preoccupied with problems of methodology and instrumentation, it is because, without better methods for discovering, ordering, and analyzing human nature and conduct, social science must continue to rely largely on prudential, subjective observation or introspection.

Among students of human behavior, the experimental psychologists have been most acutely aware of the need for better research methods. Once they had broken the barrier between *mind* and *body*, they were able to borrow from their biological colleagues instruments for measuring physiological characteristics—blood pressure, neuromuscular tensions, reaction time, and so forth—and to associate these with certain emotional states or behavior traits. Educational and social psychologists, social psychiatrists, social caseworkers, and sociologists have added to their methodological storehouse new instruments and methods—the Skinner box, the depth interview, the case study, and tests of learning, aptitude, attitude, and intelligence. Equally important has been the development of improved sampling procedures and new electronic devices for coding, computing, sorting, tabulating, and analyzing great quantities of empirical data. Armed with these research tools, survey research centers have added new and exciting dimensions to social science research in nearly every field, including the critically important field of political behavior.

The present volume, *The American Voter* (by the Survey Research Center of the University of Michigan), is an impressive monument to scientific research on American political behavior. It is not a book for the casual reader or for those unfamiliar with such pioneer studies as *The People's Choice* and *Voting* (by Paul Lazarsfeld and his associates) and *The Voter Decides* (by Angus Campbell and his staff at the Survey Research Center). This current study, incidentally, is at least a partial answer to those who have said that, unlike research in the natural sciences, social science research is noncumulative. For the authors of *The American Voter* have built their own edifice on an impressive accumulation of specialized research papers and monographs. The result is not only an invaluable body of new information and insights concerning American voting behavior but, for the behavioral scientist, an indispensable summary and analysis of an important body of scientific literature.

Most important for the student of American politics is the restoration of the *political* dimension to data that hitherto has been treated mainly, if not exclusively, in purely sociological or psychological terms.

Of the five major sections into which the book is divided, three have to do with various political aspects of the topic: "Political Attitudes and the Vote," "The Political Context," and "The Electoral Decision and the Political System." The remaining sections are concerned with the theoretical orientation of the study and with the social and economic context. The latter section deals with the effect of membership in social groupings and the role of social class on voting behavior. It also includes analyses of the economic antecedents of political behavior, agrarian political behavior, the political significance of population movement, and personality factors in voting behavior. Even in these chapters, however, the authors are concerned with sociological and psychological factors only as they have political significance. Political attitudes are analyzed in terms of the voters' perceptions of parties and candidates, partisan choice, voting turnout, the strength of party identification, and partisan regularity in voting for President. Attitudes on public policy and ideology are related to political preferences, the formation of issue concepts, and partisan change.

As a political scientist, I find this *political* orientation refreshing and reassuring. In their preoccupation with group theory and microsociology and with the personality traits or the social and economic status of American voters, political sociologists had forgotten or had minimized the importance of the *political* environment in which voting behavior takes place. It is reassuring, therefore, to find that the authors of *The American Voter*, while not neglecting the influence of groups, personality traits, and social and economic status, seek always to relate these factors to the political process, or to what Bentley called the "process of government." More specifically, they examine in detail the reciprocal effects of election laws, political systems, party organization and strategy, and electoral behavior. Although it will come as no surprise to political scientists and practicing politicians, ballot forms, nominating systems, suffrage qualifications and the like, have important and measurable effects upon voting.

The empirical basis for this profile of the American voter is an accumulation of survey research materials covering national, state, and even local elections from 1948 through 1956. Much of the information and many of the conclusions reached concerning the motivation, participation, and orientation of American voters will be familiar to students of politics, most of whom have always assumed, for example, that voting turnout is related to intensity of political preferences and involvement. This assumption is now supported by empirical evidence. It has also now been established that intensity of partisan preference is a more important factor in turnout than issue or candidate preference, and that the nonpartisan, so-called "independent" voter

is generally the apathetic, disinterested nonvoter.

Where voter preferences for party, candidate, and issues coincide or move in the same direction, turnout will be greatest. Where partisan preferences conflict with issue or candidate preferences—that is, where cross pressures are at work—turnout will decline. Moreover for the rank and file voter, partisan preferences are more likely to affect issue and candidate preferences than are either of the latter significantly to affect partisan preference.

Maurice Duverger has argued that, for most established political parties, organization is more important than ideology. In general, this is true of American parties and of American voters. Clear ideological distinctions are found only among a rather thin layer of the more highly educated voters in both major parties. For the most part, partisan preferences are conditioned by historic and family traditions, by perceptions of group or individual interest, and, of course, by occupation, education, religion, and economic and social status.

One is struck by the strength of party loyalties in the United States, loyalties which yield only slowly to upward or downward social mobility. Even the much heralded move to the suburbs, according to *The American Voter,* is not likely to produce any dramatic reorientation of partisan preferences. If the denizens of suburbia and exurbia are more Republican than their compatriots in the central city, this is mainly owing to the outward migration of Republicans from the central city and not to any extensive conversion of Democrats by the suburban environment. Suburbanites were Republicans before they became suburbanites. The suburban trend, moreover, is more than offset by the migration of rural voters with low-levels of income, education, and status into the city where they swell the ranks of an expanding Democratic party. On balance, it is the Democrats who have profited most from the growth and internal migration of the American people, not only from rural to urban areas, but also from East to West and South to North. Today the Democrats comprise a clear and impressive majority of the voters.

What significance this may have for the Presidential election of 1960, the authors do not say. But for those who read between the lines, a Democratic victory would seem to be highly probable. How else can one interpret the following statements: (i) "in both 1952 and 1956 the number of people who called themselves Democrats outnumbered those who identified themselves as Republicans . . ." (ii) "for the most part those Democrats and Independents who voted for Eisenhower . . . preferred the man but not the party. . . . Three out of five in 1952 and three out of four in 1956 were not willing to support the Republican slate even though they voted for its Presidential candidate . . ." (iii) "Without Eisenhower's name at the top of their ticket in 1954, the Republicans could not hold either house of Congress." (And, although the authors' data do not extend to the 1958 election, the results in that year, even more than in 1954, confirm the overwhelming preference of the American voter for the Democratic party.)

Only by interpreting 1952 and 1956 as *realigning* elections (as were those of 1860, 1896, and 1932) could one attribute the Eisenhower victories to a shift in political preference from the Democratic to the Republican party. A more reasonable interpretation, in view of the Congressional, gubernatorial, and state legislative elections of 1952, 1954, 1956, and 1958, would view the Eisenhower victories not as *realigning* but as *deviating* elections. "The Eisenhower elections," say the authors, "did not presage a critical realignment of partisan attachments. They did not seriously threaten the prevailing Democratic majority, and the factors that made them possible seem not to have been of a long-term character."

It is possible, of course, that the pattern of party preferences at the Congressional and state levels bears no relation to the pattern of party preferences at the Presidential level. If this were true, then a Republican presidential candidate, even one lacking the charismatic qualities of General Eisenhower, might confidently expect to win in 1960. Moreover, special events (a Korean War, a Far Eastern crisis, a sudden change in the business cycle, and so forth), which are impossible to predict, might well produce another Presidential election *deviating* from the *normal* or Congressional pattern of party preference. But the authors of *The American Voter* wisely avoid entanglement in the hazardous business of political prediction or forecasting. Their emphasis throughout is on trying to understand, through scientific anaylsis, what has occurred, not on predicting what may or must occur in the future.

Although there are strong overtones of radical behaviorism and determinism in this study, the authors reject any simplistic interpretation of voting behavior, made in terms solely of Newton's first law. To be sure, they speak frequently and, I believe, too confidently of the major *causes* of the voters' political participation and preferences, and their basic theoretical posture is in terms of what they describe as a "Funnel of Causality." But this funnel of causality is a far cry from the simple stimulus-response (S-R) formula of the radical behaviorists. It embraces not only the familiar theory of a psychopolitical field but strives to take account of historical, institutional, and conceptual factors too often neglected by behavioral scientists. The authors recognize the difficulty of distinguishing cause and effect, a relation that may as well be symmetrical as asymmetrical. The concept of causality used in *The American Voter* is limited to "uniformities of sequence observed in time past, which may be expected in the absence of exogenous factors to hold in the future."

Since this is a study not of billiards or ballistics but of the voting behavior of human beings, the authors focus their attention not only on those items in the voter's environment which may impinge upon him in the process of voting but also and mainly upon the way the voter perceives these items and their relation to his final decision. "By casting a vote, the individual acts toward a political world whose objects he perceives and evaluates in some fashion. . . . As a result, measuring perceptions and evaluations of the elements of politics is a first charge on our energies in the explanation of the voting act." It is, in short, the "cognitive map of national politics held by the American electorate . . ." that is the major concern of the authors of *The American Voter.*

By thus emphasizing the importance of cognition and evaluation in the voting process, the behavioral scientists at the Survey Research Center have taken a long step toward the recognition, one might say the restoration, of at least some element of rationality in voting behavior. In doing so, they point again and again to the importance of communication and education in the politics of democracy. What is here called the "cognitive map of national politics" is one aspect of what Rebecca West once described as the "Face of

the Age." Too frequently the voter's "cognitive map of national politics" is a compound of myth and metaphor resulting from inadequate, inaccurate, or even deliberately deceptive reports which are gathered from gossip and rumor filtered through imagination, wishful thinking, and fantasy. As Rebecca West has said, "If people do not have the face of the age set clear before them, they begin to imagine it; and fantasy, if not disciplined by intellect and kept in faith with reality, . . . dwells among the wishes and fears of childhood and so sees life either as simply answering any prayer or as endlessly emitting nightmare monsters from a womb-like cave." In Freudian terms, when the ego function is starved or tranquilized, political behavior degenerates into an expression of mass anxieties, fears, and hates which turn to some *totemic* father image for relief.

No review can do justice to this volume. It represents a major contribution to the literature of American politics. Moreover by restoring *politics* to the study of voting behavior, it should help to bridge the gap that, unfortunately, seemed to be developing between political and behavioral science.

Eagle-eyed "old school" readers of *The American Voter* can, of course, find plenty to criticize. They can, for example, question whether so elaborate an apparatus is necessary to "prove" the most obvious of political truisms or clichés. Surely, they might say, it is no great scientific revelation to learn that "whenever a group holds distinctive beliefs about some issue, then within the group a differentiation appears between members according to the strength of their group identification." Or that "group cohesiveness is one determinant of the influence a group can wield over its membership." Or, again, that "a lower-class grouping comes to have significance as an entity because there is an upper-class grouping that is perceived as opposed to it." When told that "people do not as a rule come to choose . . . [their] occupations in order to implement prior political involvement," most readers may well ask, "whoever said they did?" Nor will they gasp in astonishment to learn that voters in "high status" occupations are less "worried" economically than "blue-collar workers." Or that "members of farm organizations . . . tend to be more politically involved than non-members . . ." Or that "various social categories are differentiated in their behavior because they receive different stimuli." Or that "the more meaning an individual can find in the flow of political events, the more likely it is that these events will maintain his interest."

The "old school" critic may also complain about the somewhat turgid style of writing that the authors employ and the polysyllabism to which they seem addicted. But these faults are minor ones when set against the rich harvest of knowledge and insight that awaits the careful reader of this book.

PETER H. ODEGARD
Department of Political Science, University of California, Berkeley

Handbook of Aging and the Individual. Psychological and biological aspects. James E. Birren, Ed. University of Chicago Press, Chicago, Ill., 1959. xii + 939 pp. $12.50.

One of the difficult problems confronting research workers in the field of gerontology is the lack of source materials that bring together the experimental studies published in a wide range of scientific journals. This book makes a valuable contribution toward resolving the problem, at least with respect to psychological research.

This volume is the first of three handbooks to stem from grants provided by the National Institutes of Health to the University of Michigan; the university, in turn, acted as the administrative center for a "multi-university sponsored training program for university personnel in the field of social gerontology." In the words of the editor, "The purpose was to prepare a handbook which would be an authoritative technical summary of the scientific and professional literature on the individual or behavioral aspects of human aging with supporting information from infrahuman species. . . . It is primarily intended for use by graduate students and professional scientific specialists as a reference work." A total of 30 authors prepared chapters of the book.

There are four main divisions of the volume: "Foundations of research on aging"; "Biological bases of aging"; "Aging in environmental settings"; and "Psychological characteristics of aging." As must be true of any volume with multiple authors, there is a wide range in the degree of excellence of the various chapters.

The limitations of space will not permit detailed examination of individual chapters, but comments will be made about selected areas. In the first section Birren outlines the general principles of research on aging, describing research in the field as "the systematic inquiry into the regularities in the structures and functions of living organisms as they move forward in time in the latter part of the life span." Actually, most of the observational data reported in the volume deal with comparison of differences between young and old organisms, and very few indicate progressional changes during adult life. The chapter concludes with a research-evaluation outline which formalizes the critical issues in experimental design. Birren made a unique departure in choosing a pair of philosophers, Maria Reichenbach and Ruth Anna Mathers, to deal with the general scientific philosophy of time. Landahl develops mathematical models of survival curves, mortality, population growth, tissue regeneration, as well as psychological processes such as conditioning and other functions of the central nervous system.

The major emphasis of the section, "Biological bases of aging," is on the morphological, biochemical, and physiological changes in the nervous system. The biology of senescence in lower forms of animals is presented by Lansing, and the genetic aspects of aging in human beings are discussed by Kallman and Jarvik. Although no one can deny the importance of the nervous system in determining behavior, the influence of the internal environment on the functioning of the cells of the nervous system is not adequately stressed. Other organ systems, essential for maintaining the adequacy of the internal environment (heart, lungs, blood vessels, and kidney), are not considered. Although many organs of the body (including muscles, glands, and even the brain) can fail to function for varying periods of time without threat to our existence, even temporary failure of the heart, the respiratory system, or the kidneys can terminate life. Consequently, it is imperative that students of behavior be cognizant of some of the basic physiological changes that occur with advancing age in these vital organs. It seems that at least one chapter should have been devoted to this general topic.

The content of Part 3, "Aging in environmental settings," is difficult to appraise critically in terms of the rationale of the organization. Individual chapters deal with such diverse topics

as the social-cultural background of the aging individual, including a review of Greek and Roman views of aging; a detailed analysis of human mortality curves; the influence of age on work and occupational skills; and psychopathology. Some chapters in this section include materials that appear in other chapters—for example, on aspects of perception.

Although this section presumes to deal with aging in an environmental setting, the only chapters that seem to me to be concerned primarily with environment are those on the social and cultural background (von Mering and Weniger), the discussion and evaluation of human mortality curves (Hardin B. Jones), and, to some degree, the chapter on work and occupational skills (McFarland and O'Doherty). If one takes the position that psychopathology is primarily the result of environmental stresses, then its inclusion in this section may be warranted. Since Busse, in the chapter on psychopathology, deals with both organic and functional disturbances in a straightforward and lucid fashion, the question may be raised as to its pertinence in this section in preference to its inclusion in section 4.

The most comprehensive section of the *Handbook*, part 4, is concerned with the psychological characteristics of aging. It is especially in the treatment of formulations of learning theory and aging (Harry Kay) and personality theory and aging (Klaus Riegel) that this volume makes a notable contribution to the field of gerontology. Under the impetus of the current trend toward theoretical formulation of the various psychological domains, as presented by Helson, by Melvin Marx and by Estes, Koch, MacCorquodale, and others (and most recently in the three volumes edited by Koch), the extension of psychological theory to studies of aging, especially as suggested in the chapters by Kay and Riegel, might be applied in other areas as well. The review by Jerome of the experimental studies of age and learning and Kuhlen's discussion of aging and life-adjustment are both enhanced by the development of the theoretical issues in the immediately preceding chapters. By utilizing a consistent developmental treatment in which theories of emotion and the nature of intelligence provide a framework for interpreting research in those areas, the graduate student will gain perspective and the instructor an invaluable teaching device.

The application of Hull's theory of learning in the conceptual framework of aging research, according to the issues raised by Kay, will challenge the experimenter to more precise investigation of the differences in the nature of the learning process for various age groups. Furthermore, Kay's evaluation of the many theoretical concepts particularly relevant to aging should stimulate much research in this area. On the other hand, in the chapter by Riegel, elementary constructs—for example, the three major systems (the id, ego, and superego) of Freud—are included and explained; surely the sophisticated graduate student of psychology toward whom this volume is directed will have mastered these concepts earlier in his training.

Unfortunately a dearth of research in many of the areas covered in this volume limits the documentation to studies that are suggestive rather than definitive. Lengthy descriptions of research, based on such small and potentially biased samples that the results cannot be considered conclusive evidence for a general phenomenon, are reviewed by several authors who wish to confirm or support a contention. For example, in his chapter on perceptual processes, Braun discusses at length the Korchin and Basowitz study concerning the perception of ambiguous stimuli, and he notes that decision (reaction time) patterns for early and middle stimuli in a series were not appreciably different between an old group (age range 65 to 85 and older) and a young group (age range 22 to 33), although the young subjects shifted their responses earlier in the stimulus series than did the old. In this study there were 24 subjects in the young group and 36 in the old group. Botwinick also refers to the same study to illustrate group differences in ego organization. Again the research is described in detail with emphasis on the point made by Korchin and Basowitz that their data are a reflection of "less adequate ego organization of older subjects." In the chapter on intelligence and problem solving, Harold E. Jones refers to the study again to point out speed and power differences between young and old subjects in performing many kinds of tasks. To the reader, constant referral by several authors to a single study places undue emphasis on the importance of that study to the field, especially when its conclusions merely are suggestive, as the investigators themselves have stated. On the other hand, one of the earliest studies in aging was the thorough and scholary investigation by Jones and Conrad, which Jones modestly discusses quite briefly and which is barely mentioned by other authors in the *Handbook*.

One of the most lucid chapters, that by Welford on psychomotor performance, describes and interprets ingenious experiments, within the framework of information theory.

The volume highlights the scarcity of experimental data on which superstructures of theory about aging have been built and offers a challenge for future research. There are areas of overlap and a degree of repetitiousness that should not occur in a handbook. In other areas—for example, information theory—not enough background material is given to permit evaluation of the psychological theories developed. Many theoretical issues are raised, but they are not always in the context of aging. Individual authors vary widely in the extent to which a critical evaluation is made of the data included.

In general, the book makes a significant contribution to the psychological aspects of aging and summarizes age changes in the nervous system. The inclusion of "and biological aspects" in the subtitle is a misnomer for the volume fails to cover large areas of biology and physiology. A large amount of material scattered through the literature is brought together in some semblance of structure, along with extensive bibliographic material. The detailed subject and author index is valuable for locating specific information.

James Birren is to be congratulated for this contribution to the future of gerontology.

N. W. SHOCK
Gerontology Branch, Baltimore City Hospitals, Baltimore, Maryland

High-Energy Electron Scattering Tables. Robert Herman and Robert Hofstadter. Stanford University Press, Stanford, Calif., 1960. 278 pp. $8.50.

This book contains a great deal of information useful in analyzing high-energy electron scattering experiments. The numerical tables which are given include: trigonometric functions for evaluation scattering cross sections; charge density distributions and form-factors for 13 nuclear models; the

Rosenbluth cross section for protons and neutrons; deuteron form-factors and wave functions for three models; inelastic scattering cross sections for deuterons composed of point nucleons and extended nucleons; scattered electron energies for elastic scattering from light nuclei; the Møller cross section and kinematical factors for electron-electron scattering. In addition to extensive tables and instructions for their use, the book contains a brief review of the subject of electron scattering, an exhaustive list of references, a summary of experimental nuclear size parameters, and many useful graphs.

The authors are careful to state that comparison of experiments with the given form-factors requires the validity of the Born approximation and, for this reason, the tables are most applicable for light nuclei, high electron energies, and small scattering angles. However, under typical experimental conditions, errors due to using the Born approximation are usually comparable to, and sometimes much larger than, the differences between cross sections predicted by the various nuclear models. Thus, the inclusion in the tables of form-factors for many very similar nuclear models is of doubtful merit.

On the other hand, the deuteron inelastic scattering tables for the extended nucleon case are presented for just one value of the charge and magnetic moment radii of the proton, and three values of the neutron magnetic moment radius. Clearly, tabulations for many more sets of radii would be necessary in order to obtain accurate, best-fit values for these important nucleon parameters.

In conclusion, although the tables in this book do not eliminate the need for difficult and tedious hand (or digital computer) calculations in analyzing electron scattering experiments, they serve a very useful purpose as an aid in designing experiments and as a guide to more precise analysis of results.

SAMUEL PENNER
Radiation Physics Division,
National Bureau of Standards

Elements of Ion Exchange. Robert Kunin. Reinhold, New York, 1960. viii + 164 pp. Illus. $5.75.

This small volume provides a basic understanding of ion exchange techniques for those with a limited theoretical background.

Up to now most works on this subject have been of the advanced theoretical type, of little use to executives or operating personnel. The use of ion exchange methods has now become so widespread in the laboratory and in industry that few are the individuals not affected by this technique. The biochemist and the nuclear researcher will find this book useful and interesting reading, while the industrial chemist and agronomist will find that the book gives them a broad view of ion exchange.

A. EDWARD A. HUDSON
Goldsboro, North Carolina

The Open and Closed Mind. Investigations into the nature of belief systems and personality systems. Milton Rokeach. Basic Books, New York, 1960. xv + 447 pp. $7.50.

Ten years ago, *The Authoritarian Personality* traced anti-Semitism and ethnocentrism to a proto-Fascist personal world view that the California authors interpreted as a defensive maneuver to shore up a precarious facade of strength against inner weakness and unrecognized, but threatening, impulses. The combination of fertile hypothesis and technical laxity which characterized this work stimulated a decade of research checking its results and criticizing or refining its methods. Now Milton Rokeach, a student of the late Else Frenkel-Brunswik (of all the authors who contributed to *The Authoritarian Personality*, she extended its principles farthest in the study of cognitive functioning), has come forth with a volume that takes a fresh start, employs new methods, and arrives at a different but partially congruent appraisal of much the same ground—the intersection of personality, ideology, cognition, and attitude. It is an impressive performance.

Although 22 collaborators are listed, mostly former students of the author, the book is essentially a solo performance, a monograph reporting an imaginative program of integrated, small-scale studies initiated in 1951. In an era of large projects, Rokeach shows what an ingenious and single-minded social psychologist can still accomplish with modest support.

Taking seriously the criticism that the F (Fascism) scale developed in *The Authoritarian Personality* tapped right-wing rather than general authoritarianism, Rokeach develops a conception of *dogmatism* as a characterization of people's belief systems, and he constructs a scale for measuring dogmatism which is intended to be free of content bias toward the ideological left or right. Items on his scale are phrased to identify the dogmatic or closed-minded person as one who tends to accentuate the differences between his beliefs and the belief systems that he rejects; to regard man as isolated and helpless and the future uncertain; to be concerned with power and status; to be, as a "true believer," intolerant of renegades and disbelievers; and to discount the present for a utopian view of the past or future. Validation studies of the dogmatism scale and of a companion scale of *opinionation* (the tendency to accept or reject others depending on whether they agree or disagree with one's views) lend support to Rokeach's contention that he has arrived at more general variables that are free of the ideological bias limiting the utility of the scales developed in *The Authoritarian Personality*.

With considerable experimental ingenuity, Rokeach shows how dogmatism hampers problem-solving within the framework of novel belief-systems. Other sections deal with *dis*belief-systems, and with the role of threat and anxiety in the genesis of dogmatism. A wide variety of methods and of types of data are called upon.

The author anticipates certain formal criticisms that must be made of the book. Like the measures employed in *The Authoritarian Personality*, Rokeach's similarly constructed scales are surely not unidimensional. They are also not free of probable response-set effects, since agreement with an item always yields a score in the direction of dogmatism (or opinionation). While differences in acquiescence will not account for his impressive differential effects, a good many of the positive interscale correlations must be discounted to some degree, and some of the features that Rokeach ascribes to dogmatism, as such, may rather go with the "yea-saying" personality. Further, many of the data are based on comparisons of extreme groups, yielding sizable differences that would correspond to much less impressive correlation coefficients.

The treatment of dogmatism in relation to cognitive processes would benefit from intellectual contact with G. S. Klein's research on cognitive style, which would seem to offer alternative possibilities for conceptualization. Miss-

ing, also is Klein and Frenkel-Brunswik's complementary psychoanalytic emphasis on motivational processes, although Rokeach accepts Frenkel-Brunswik's developmental-dynamic account as being probably valid for dogmatism.

Most controversial is Rokeach's reinterpretation of racial prejudice; according to him, racial prejudice is a special case of a more general principle of discrimination according to similarity of belief. His responsible challenge to prevalent views can only be fruitful, but his data will suffice to convince only the most open-minded. Clearly more evidence is called for here.

All told, this is an original, provocative, and meaty book that joins *The Authoritarian Personality* as an achievement and as a stimulus to further work.

M. Brewster Smith
Department of Psychology, University of California, Berkeley

The 3-j and 6-j Symbols. Manuel Rotenberg, R. Bivins, N. Metropolis, and John K. Wooten, Jr. Technology Press, Cambridge, Mass., 1960. viii + 498 pp. $16.

Studies of the coupling of angular momenta in quantum physics and of the angular distribution of reaction products have given rise to a geometrical theory that constitutes an extension of vector and tensor algebra. The elements of this theory are sets of variables, and the number of variables in each set is often indicated by $2j + 1$, j being the symbol that usually represents an angular momentum quantum number ($j = 1$ corresponds to a vector). Certain functions of the parameters j, which have a central part in the theory, are called 3-j, 6-j, 9-j, 12-j coefficients. They are also known by various symbols suggested by different authors or by the names of the authors themselves (Clebsch-Gordan-Wigner coefficients, Racah coefficients). Tables of these functions have been prepared in the past, but this work appears to represent a more systematic and permanent contribution than previous ones. It is also the first major tabulation available on the ordinary book market. The preparation of the book appears to have been carefully thought out. Introductory notes (37 pages) provide the necessary definitions, numerous properties of the functions, connections with other work, and details on the preparation and use of the tables. The tables themselves are very voluminous (over 450 pages printed by photo-offset from a computer output) and consist of powers of prime factors, that is, in essence, of the logarithm, of the desired functions. This notation was chosen after considerable discussion, and I concur with it.

U. Fano
National Bureau of Standards, Washington, D.C.

Reprints

Abbott, Ira H., and Albert E. Von Doenhoff. *Theory of Wing Sections.* Including a summary of airfoil data. Dover, New York, 1960. 703 pp. $2.95. A corrected but not extensively revised version of ed. 1, 1949.

Chandrasekhar, S. *Radiative Transfer.* Dover, New York, 1960. 407 pp. $2.25. An unabridged, slightly revised reprint of ed. 1, 1950.

Crow, Edwin L., Frances A. Davis, and Margaret W. Maxfield. *Statistics Manual.* Dover, New York, 1960. 305 pp. $1.55. Republication of *NAVORD Report 3369—NOTS 948.*

Dickson, Leonard Eugene. *Algebras and Their Arithmetics.* Dover, New York, 1960. 253 pp. $1.35. Republication of ed. 1, 1923.

Eisenhart, Luther Pfahler. *Coordinate Geometry.* Dover, New York, 1960. 309 pp. $1.65. Republication of ed. 1, 1939.

Franklin, Philip. *Differential Equations for Engineers.* Dover, New York, 1960. 306 pp. $1.65. Republication of *Differential Equations for Electrical Engineers,* 1933.

Gray, Andrew. *A Treatise on Gyrostatics and Rotational Motion.* Theory and applications. Dover, New York, 1959. 550 pp. $2.75. Unabridged republication of ed. 1, 1918.

Greenhill, Alfred George. *The Applications of Elliptic Functions.* Dover, New York, 1960. 368 pp. $1.75. Republication of ed. 1, 1892.

Kramer, Samuel Noah. *History Begins at Sumer.* Doubleday, Garden City, N.Y., 1960. 272 pp. $1.45. Reprint of ed. 1, 1956. Kramer, an outstanding Sumerologist, describes 27 "firsts" in recorded human history—the story of schools, social reforms, political and religious ideas, as well as of the world's first tax reduction—and in so doing presents a fascinating account of life 5000 years ago.

Rosen, Edward, Translator. *Three Copernican Treatises.* "The *Commentariolus* of Copernicus," "The Letter against Werner," and "The *Narratio prima* of Rheticus." Dover, New York, 1959. 294 pp. $1.75. An unabridged revised republication of ed. 1, to which has been added an annotated Copernicus bibliography, 1939–1958 (69 pp.).

Von Mises, Richard. *Theory of Flight.* Dover, New York, 1960. 645 pp. $2.85. Unabridged republication of the English translation published by McGraw-Hill in 1945. Introduction written for this edition by Kurt H. Hohenemser.

New Books

Mathematics, Physical Sciences, and Engineering

Horn, Milton B. *Acrylic Resins.* Reinhold, New York; Chapman and Hall, London, 1960. 191 pp. $4.50.

Institut International de Chimie Solvay. *Nucleoproteins.* Interscience, New York; Stoops, Brussels, Belgium, 1960. 364 pp. $10.50. Proceedings of the 11th Solvay Conference, held 1–6 June 1959 in Brussels.

Ipsen, D. C. *Units, Dimensions, and Dimensionless Numbers.* McGraw-Hill, New York, 1960. 248 pp. $6.50.

Jastrow, Robert, Ed. *The Exploration of Space.* Macmillan, New York, 1960. 160 pp. $5.50. This volume contains the papers presented at a symposium held in 1959. As a survey of the recent developments in space sciences, it includes descriptions of American space rockets, with data on their payloads and on estimated completion dates for rockets under development and their suitability for specific lunar and planetary exploration missions. Contributors, include James Van Allen Homer E. Newell, G. P. Kuiper, and Harold Urey.

Katritzky, Alan R., and Jeanne M. Lagowski. *Heterocyclic Chemistry.* Methuen, London; Wiley, New York, 1960. 274 pp. $8.50.

Kaye, Joseph, and John A. Welsh. Eds. *Direct Conversion of Heat to Electricity.* Wiley, New York, 1960. 23 chapters. $8.75. Papers presented at a special program offered by Massachusetts Institute of Technology (1959) and discussing thermoelectric and thermionic energy conversion, magnetohydrodynamic conversion, and fuel cells.

Klingsbert, Edwin, Ed. *Pyridine and Its Derivatives.* Interscience, New York, 1960. 623 pp. $49. Contributors to this volume (part 1 of four proposed parts) include R. A. Barnes, Frederick Brody, and Philip R. Ruby. The papers included are on properties and reactions of pyridine and its hydrogenated derivatives and on synthetic and natural sources of the pyridine ring.

Lawrence, John R. *Polyester Resins.* Reinhold, New York; Chapman and Hall, London, 1960. 260 pp. $5.75.

Lederer, Michael, Ed. *Chromatographic Reviews.* Progress in chromatography, electrophoresis and related methods. vol. 2. Elsevier, New York, 1960 (order from Van Nostrand, Princeton, N.J.). 203 pp. Reprints of review articles published in the *Journal of Chromatography*; articles not originally in English have been translated.

Mayall, R. Newton, and Margaret W. Mayall. *A Beginner's Guide to the Skies.* Putnam's, New York, 1960. 184 pp. $2.50. Intended for the novice, this book contains no technical material; in general the text is based on Olcott's *Field Book of the Skies.*

Mollenstedt, G., H. Niehrs, E. Ruska, Eds. *Proceedings of the Fourth International Conference on Electron Microscopy.* vol. 1, *Physikalisch-Technischer Teil.* Springer, Berlin, 1960. 867 pp. DM. 228.

Reports

Marine Planation of Tropical Limestone Islands

Abstract. Geological studies in the western Atlantic indicate that sea level is now near its highest position since the Pleistocene, and that intertidal erosion at this level has been negligible. The evidence conflicts with the idea that many coral reefs were recently planed down from a higher stand of the sea.

The western Atlantic contains thousands of islands and cays of cross-bedded, friable limestone. The form and structure of these deposits suggest that they accumulated as shore dunes of calcareous sand. Many of the best-preserved cemented dunes rest on submerged platforms approximately 3 to 6 meters below sea level. Consequently, it is judged that the dunes were formed during a low stand of the sea (*1*, *2*).

An outstanding characteristic of these "eolianite" deposits is that the depositional forms of the dunes have, in many cases, been little modified by erosion.

Kaye (*2*) has documented examples of well-preserved "fossil" dunes in Puerto Rico, where depositional slopes frequently extend below sea level, interrupted chiefly by a shallow intertidal nip. Sheltered shores of cays of Bermuda and the Bahamas also provide hundreds of examples of cemented dunes drowned in a few meters of water. Excellent examples form the 100-mile-long archipelago of the Exuma Cays, in the Bahamas. These rocky cays lie in parallel chains along what probably are successive shores of a formerly retreating sea. As in Puerto Rico and Bermuda, the slopes of the dunes are unmarked by high terraces and there has been but little intertidal erosion at present sea level. There is no trace of attached barnacles, mollusks, or corals on these slopes, such as might mark the levels of recent stands of sea level above the present high-tide mark. And there are no unconsolidated marine sediments above the level of modern beaches. The maximum amount of sea-level undercutting that I have observed in the Bahamas is about 4 meters. From historical documents, Kaye (*2*) has shown that the erosion of an intertidal kerf of this depth should require at least 2200 years.

The average rate at which marine terraces are cut in limestone is not known. Nevertheless, widely entertained explanations of reef and island profiles depend on an assumption that the shores retreat rapidly before intertidal erosion.

There is substantial agreement that the sea has risen several scores of meters in the past 10,000 years because of the melting of the continental glaciers. But there is sharp disagreement as to whether the sea reached an appreciably higher level and then subsided to the present stage. It is difficult to establish the exact date at which the present level was reached, but scattered radiocarbon analyses indicate a position within 1 or 2 feet of the present level some 2000 to 3000 years ago.

Radioisotope ages of Bahamian eolianites obtained at the Lamont Geological Observatory are not unequivocal, but they do provide minimum ages of the dune rocks. There is a large discrepancy between radiocarbon and radium-uranium dates. It is probable that the radiocarbon dates, ranging from about 13,000 to 30,000 years ago, are much too young, reflecting contamination through cementation and surface exchange (*3*). A date of 32,-300±3000 years was obtained by Broecker and Olson on fossil land snails which I collected from dune deposits at the Queen's Staircase, in Nassau (*3*).

On the other hand, radium-uranium dates indicate an age in excess of 70,-000 years and are in fair agreement with a ionium-uranium date for eolianite at the Queen's Staircase, obtained by Tatsumoto and Goldberg (*4*). Heinz Lowenstam (*5*) finds that the dune rocks of Bermuda are too old for dating by radiocarbon. Thus, it appears that radioisotope analyses thus far made indicate Pleistocene dates for the eolianites.

The sand of the dunes is, of course, older, and the cementing agent is younger than the dunes. It is appropriate to inquire whether the radioisotope ages of the eolianite rocks provide a meaningful measure of the ages of the dunes as geomorphic features. I believe that they do, for the following reasons.

The geological relationships indicate that both the constituent (marine) sand and the subaerial dunes probably date from a single eustatic cycle when sea level was high enough to flood parts of shelves and banks. The calcareous sand is composed mainly of aragonite, which, on exposure, becomes quickly stabilized by vegetation and cemented into firm limestone. During times of glacially lowered sea level, exposed calcareous sediments must have become cemented, and the returning sea must then have advanced over rock surfaces.

To judge from the nature of the sediments now accumulating near the limestone outcrops, erosion of the rocks produces only an insignificant quantity of second-generation sand. Consequently, I believe that very little of the lime sands which formed the ancient dunes were derived from the disintegration of older rocks. From the radiocarbon dates it appears that the sands might have originated during the Sangamon stage or a warm interval within the Wisconsin stage (*1*), but it could not have been later. If these conclusions are correct, they have far-reaching implications concerning recent eustatic changes and manifold geological phenomena associated with present sea level.

From this evidence, it seems that the erosion of limestone shores, especially those protected by coral reefs, is too slow to result in extensive planation during brief stillstands of sea level. The present broad reef platforms commonly attributed to sea-level erosion (*6*, *7*) represent a condition of approximate equilibrium between the base level of intertidal erosion and the ceiling of organic accretion. However, only a small part of a typical reef flat is demonstrably the product of sea-level planation of an adjacent limestone shore. This is contrary to the views of students who believe that pre-Pleistocene and interglacial reefs were re-

Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper.

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or tables or one of each.

For further details see "Suggestions to Contributors" [*Science* **125**, 16 (1957)].

peatedly cut down to the levels of the glacially lowered Pleistocene sea (*6*).

From the foregoing, it seems that living oceanic reefs, as well as reefs of continental margins, may be only thin veneers over older foundations (*8*). Fossil reefs well above present sea level, situated in many cases near shelf margins, may represent exposed parts of the Pleistocene foundation. Widely distributed, elevated marine terraces and reefs of the western Atlantic antedate the last time of widespread dune formation, which apparently occurred during the last interglacial stage. Elevated terraces of Pacific islands, frequently cited (with insufficient evidence) as effects of recent high sea level, should be critically re-examined. It seems likely that they also are of Pleistocene age.

NORMAN D. NEWELL
American Museum of Natural History and Columbia University, New York, New York

References and Notes

1. N. D. Newell and J. K. Rigby, *Soc. Econ. Paleontologists Mineralogists, Spec. Paper No. 5* (1957), p. 68.
2. C. A. Kaye, *U.S. Geol. Survey Profess. Paper No. 317-B* (1959), p. 128.
3. Wallace Broecker, personal communication.
4. M. Tatsumoto and E. D. Goldberg, *Geochim. et Cosmochim. Acta* **17**, 205 (1959).
5. H. Lowenstam, personal communication.
6. P. H. Kuenen, *Marine Geology* (Wiley, New York, 1950).
7. F. S. MacNeil, *Bull. Geol. Soc. Am.* **61**, 1307 (1950); R. W. Fairbridge, *Proc. Pacific Sci. Congr. Pacific Sci. Assoc., 7th Congr.* (1952), vol. 3, p. 1; P. E. Cloud, Jr., *Sci. Monthly* **79**, 195 (1954).
8. N. D. Newell, *Nat. History* **68**, 128 (1959).

23 March 1960

Y-Chromosome Inheritance of Hairy Ears

Abstract. A pedigree of hairy ear rims published in Italy in 1907 indicated holandric inheritance. The recent collection of over 20 pedigrees in India appears to show conclusively that the gene for hairy ear rims is in the Y chromosome. This is further evidence of relationship between the Mediterranean race in Europe and the population of India.

When I wrote *Human Genetics* (*1*), an Italian pedigree of hairy ear rims was regarded as a prima facie case of inheritance through a gene in the Y chromosome. But, since the pedigree was published very early (1907) and not in pedigree form, it obviously needed confirmation. While traveling in Africa in 1955, I accidentally observed three cases of hairy ears (*2*) in East Indians, two of whom were from Goa. Their pedigrees, so far as they could be obtained, were consonant with holandric inheritance, but did not furnish final proof.

In a detailed examination of all possible cases of Y chromosome inheritance in the literature, Stern (*3*) rightly suspends judgment about hairy ears, suggesting that unaffected women might transmit the trait, in which case it might be an autosomal character under sex control. Transmission from a father to all his sons, which is the pattern found, shows that the gene cannot normally be in the X chromosome, because a father always transmits his X chromosome to all his daughters and his Y to all his sons.

While studying jungle tribes in India in 1959, I collected over 20 pedigrees of hairy ear rims, generally in three generations, from the ordinary Indian population. The condition proved to be relatively frequent, especially in southern India. Two cases in native tribes, one in the Kotas and one in the Adiyar, were probably the results of miscegenation with ordinary Indian men.

The pedigrees as a whole show beyond any doubt that hairy ear rims are holandric. The inheritance is always from a father to all his sons, except in rare cases of lack of penetrance. Such exceptions are not surprising, for the amount of hair in the groove of the ear rim varies widely, even in the same family.

That the daughters of affected men do not transmit the condition is shown by three sibships in one pedigree, in which a total of ten sons (ages 33 to 54) are unaffected. In two cases there is the possibility of crossover from Y to X, but other explanations are equally likely. The condition generally develops at ages 20 to 25, and it appears to be quite independent of a hairy external auditory meatus, which is frequently found in older men of European descent. The inheritance of the latter condition has apparently never been investigated.

It appears to be significant that hairy ear rims are found in Italians (of Mediterranean race) and in the Dravidian, Indide, or Brown race in India—which is generally regarded as an Eastern extension of the Mediterranean race.

It may also be worth mentioning that in a single Australian aboriginal of the Pintubi tribe, a fringe of hairs, little more than fuzz, was observed in the ear rims (*4*). That this fringe of hairs in the ears may have wider parallelisms is shown by its occurrence in certain species of marmosets and South American monkeys, but not in other species (*5*).

R. RUGGLES GATES
18 Concord Avenue, Cambridge, Massachusetts

References

1. R. R. Gates, *Human Genetics*, 2 vols. (Macmillan, New York, 1946).
2. ———, *Acta Genet. Med. et Gemellol.* **6**, 103 (1957).
3. C. Stern, *Am. J. Human Genet.* **9**, 147 (1957).
4. R. R. Gates, *Acta Genet. Med. et Gemellol.* **9**, 10 (1960).
5. W. C. O. Hill, *Primates*, vol. 3 (Interscience, New York, 1957).

2 May 1960

Locomotor Activity of Land Crabs during the Premolt Period

Abstract. When maintained in darkness, premolt specimens of *Gecarcinus lateralis*, with or without eyestalks, show variations in level of activity according to six distinct stages. Furthermore, in darkness the rhythmic pattern of premolt crabs with eyestalks resembles that of eyestalkless premolt crabs, the intervals between principal bursts of activity being generally shorter than in nonpremolt crabs.

The spontaneous locomotor activity of land crabs, *Gecarcinus lateralis* (Fréminville), has been investigated in terms of two important characteristics, namely, (i) magnitude or level, and (ii) rhythmicity. It has already been reported that the magnitude or level of activity shown by eyestalkless individuals during the period elapsing between eyestalk removal and molt fluctuates according to six distinct stages, with the level variable during stage I, relatively high in stages III and V, and relatively low or even nonexistent in stages II,

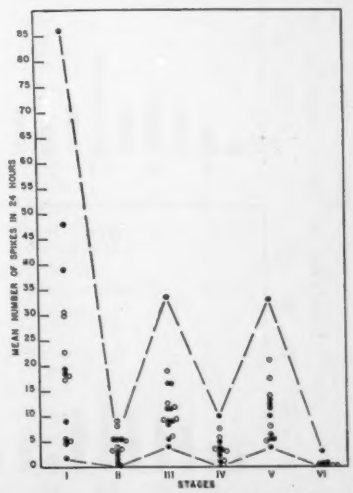


Fig. 1. Variations in level of activity recorded in darkness at 27°C from six specimens with eyestalks (open circles) and ten eyestalkless specimens (closed circles) of *Gecarcinus lateralis* during the period just prior to molt. For explanation of stages, see text.

IV, and VI (*1*). It can now be reported here that in darkness, specimens of *G. lateralis* still in possession of their eyestalks show a comparable pattern of variability in level of activity during the period just prior to molt.

These new findings are based on information derived from extended recordings in darkness at 27°C on six crabs possessing eyestalks. For some weeks these crabs had been exposed to 12 hours of continuous artificial light and 12 hours of continuous darkness every 24 hours before being placed in the activity chambers. Three crabs molted on the 21st, 22nd, and 40th day, respectively, after first exposure to darkness. The remaining three crabs did not molt until the 72nd, 78th, and 180th day, respectively, after first exposure. Despite wide variation in length of time elapsing before molt, each crab, just prior to molt (*2*), showed fluctuations in level of activity comparable to those reported earlier for 10 eyestalkless crabs. Figure 1 gives these variations in level for both eyestalkless crabs and crabs retaining their eyestalks. No attempt has been made in Fig. 1 to indicate the duration of each stage of activity. Duration depends upon several different factors, including season of the year and size of the crab.

Gecarcinus lateralis exhibits a diurnal (diel) rhythm of locomotor activity in the field, with the active period occurring at night (*3*). Likewise, in the laboratory, when it is exposed to natural daylight and night, this crab tends to be active at night and quiescent during the day. The overt diurnal rhythm of activity in the laboratory persists when a crab previously exposed to natural daylight and night is placed in constant darkness.

Persistence of overt rhythmic activity in constant darkness at 27°C has now been demonstrated for six nonpremolt specimens of *G. lateralis* with eyestalks after prolonged exposure of these crabs to 12 hours of continuous artificial light and 12 hours of continuous darkness every 24 hours. Activity records made by these crabs show a period length somewhat different from 24 hours. For instance, in commencing its active period, one crab that had been in constant darkness for 101 days exhibited a more or less regular daily delay of approximately 1.4 hours, thus yielding a period length of 25 hours 25 minutes. Periods with a natural length somewhat greater or less than 24 hours have been reported for many plants and animals maintained under constant environmental conditions (*4*).

When, in darkness, a crab that retains its eyestalks approaches molt, its rhythm of locomotor activity becomes increasingly variable in phase and continues to vary in this way for at least 1 or 2 weeks following ecdysis, while hardening of the new exoskeleton is being completed. A comparable variability in phase occurs in this species of crab when premolt growth is induced by eyestalk removal (*3*).

During analysis of activity records, counts of activity spikes appearing on the recordings are made for successive intervals of 4 hours. Peaks of activity can be recognized within any given 24-hour period, the highest being designated the "principal peak of activity." In Fig. 2 there appears the percentage distribution of principal peaks of activity at various 4-hour intervals as recorded in darkness from eyestalkless crabs and from crabs retaining their eyestalks. In nonpremolt crabs with eyestalks (Fig. 2*A*), a 24-hour period intervened between principal peaks of activity during 34 percent of the time, while principal peaks separated by 20 to 28 hours occurred during 64 percent of the time. The pattern changed markedly when a crab possessing eyestalks approached molt (Fig. 2*B*). Now principal peaks of activity occurred at 24-hour intervals during only 18 percent of the time and separation of principal peaks by periods of 20 to 28 hours occurred during only 36 percent of the time. In eyestalkless premolt crabs (Fig. 2*C*), principal peaks of activity occurred at 24-hour intervals during 17 percent of the time and were separated by intervals of 20 to 28 hours during 41 percent of the time. Thus premolt crabs, whether with or without eyestalks, manifest a weakened diurnal rhythm. Their principal peaks of activity tend to be separated often by

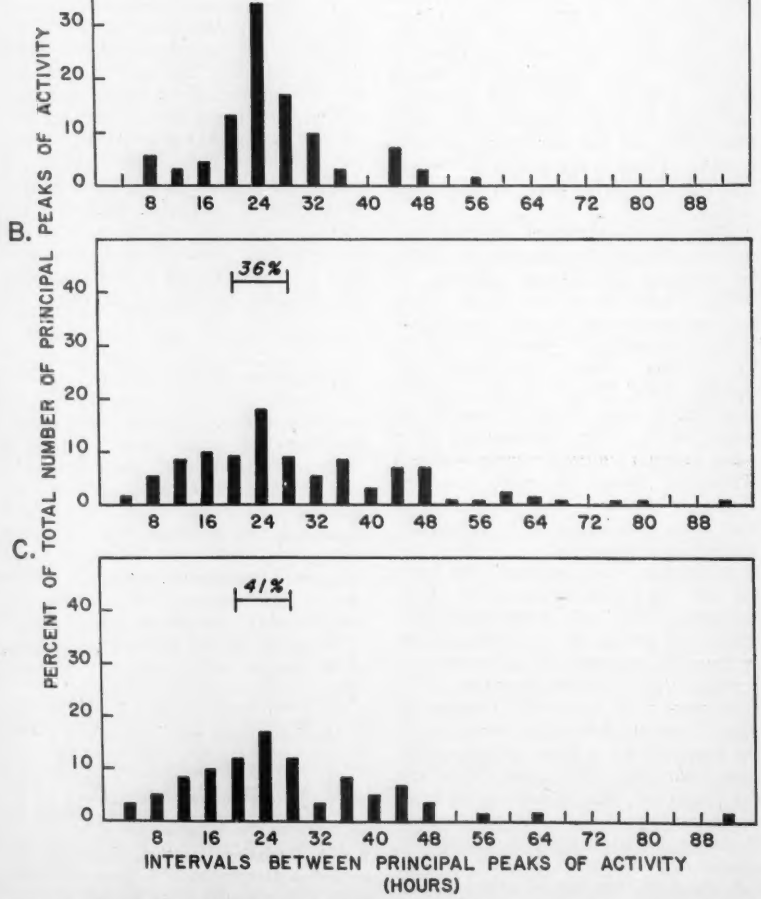


Fig. 2. Percentage distribution of the principal peaks of activity as recorded in darkness at 27°C from (*A*) three nonpremolt crabs (*Gecarcinus lateralis*) possessing eyestalks, (*B*) six crabs with eyestalks during the premolt period, and (*C*) four eyestalkless crabs during the premolt period. Counts were made at successive intervals of 4 hours.

relatively short intervals, mainly those of 12 and 16 hours.

The results of this work indicate that in terms of locomotor activity a premolt crab that retains its eyestalks and one that is eyestalkless are not dissimilar. In level and in rhythmicity, locomotor activity after eyestalk removal appears to follow a pattern characteristic of any crab in darkness making preparations for molting, including one that retains its eyestalks. One may suggest that alterations in locomotor activity during the premolt period may be attributed in an eyestalkless crab to the loss of centers for the synthesis and release of molt-inhibiting hormone and, in a crab possessing its eyestalks, to the withholding of molt-inhibiting hormone from the hemolymph. There is a strong possibility that responsibility for the control of locomotor activity in *G. lateralis* may rest with that portion of the neuroendocrine system concerned with the regulation of molting. The changes noted in darkness concerning the intensity and rhythmicity of locomotor activity prior to molt may, like rapid limb regeneration and precocious uptake and retention of water (see *5*), be part of preparations for molting and therefore a sign that ecdysis is imminent.

In conclusion, it may be suggested that since eyestalk removal appears to weaken but not to destroy the 24-hour rhythm of locomotor activity, it would seem that in the land crab, *G. lateralis*, either the biological clock does not reside in the eyestalks or accessory clocks exist elsewhere (*6*).

DOROTHY E. BLISS

American Museum of Natural History and *Albert Einstein College of Medicine, New York, New York*

References and Notes

1. D. E. Bliss and P. C. Sprague, *Anat. Rec.* **132**, 417 (1958).
2. Proximity to molt is determined by use of a regenerating limb as an index. (For descriptions of this method, see *5*.)
3. D. E. Bliss and P. C. Sprague, *Anat. Rec.* **132**, 416 (1958).
4. E. Bünning, *Die Physiologische Uhr* (Springer-Verlag, Berlin, 1958), p. 10; J. E. Harker, *Biol. Rev. Cambridge Phil. Soc.* **33**, 23 (1958); K. S. Rawson, in *Photoperiodism and Related Phenomena in Plants and Animals*, R. B. Withrow, Ed. (American Association for the Advancement of Science, Washington, D.C., 1959), p. 796; V. G. Bruce and C. S. Pittendrigh, *Am. Naturalist* **91**, 190 (1957); C. S. Pittendrigh and V. G. Bruce, in *Rhythmic and Synthetic Processes in Growth*, D. Rudnick, Ed. (Princeton Univ. Press, Princeton, N.J., 1957), p. 90.
5. D. E. Bliss, in *Bertil Hanström. Zoological Papers in Honour of his 65th Birthday*, K. G. Wingstrand, Ed. (Zoological Institute, Lund, Sweden, 1956), p. 56; D. E. Bliss, in *Physiology of Crustacea*, T. H. Waterman, Ed. (Academic Press, New York, 1960), vol. 1, p. 561.
6. This work was supported by research grant G-4006 from the National Science Foundation. A detailed account of these studies is in preparation.

29 February 1960

Late Tertiary Microflora from the Basin and Range Province, Arizona

Abstract. Sediments of probable Clarendonian age from central Arizona have furnished the only late Tertiary pollen assemblage known from the Southwest. The associated trees, shrubs, and herbs resemble the chaparral and conifer-oak woodland communities of the semiarid foothills and mountains of central and southeastern Arizona, and suggest a late Tertiary landscape and climate for central Arizona similar to that of today.

A well-preserved microflora from central Arizona provides the first good record of the late Tertiary vegetation of an area remarkable for its scarcity of Tertiary plant mega- and microfossils (*1*). The recently discovered fossil site occurs near 5600 feet altitude in the mountains of the Basin and Range Province, about 4 miles northwest of Prescott and 30 to 40 miles southwest of the Colorado Plateau.

The polliniferous sediments are a rhyolitic tuff, at least in part water-laid, sandwiched between volcanic flows. The sequence is similar in lithology and probably more or less equivalent in age to the Hickey formation (*2*) described from the adjacent Jerome area to the east and tentatively assigned to the Pliocene (*3*). Recently, Lance (*2*) has discovered fragmentary camel bones in tuffs within a few feet below the pollen-yielding sediments; he thinks these remains are like some from the Walnut Grove fauna, found in similar lithologic sequence, about 20 miles south of Prescott. This fauna contains elements indicating a Clarendonian provincial age (*2*). Reference of the polliniferous sediments to the late Miocene or early Pliocene seems in line with the regional geology and paleontology.

Scattered thick deposits of gravel and interbedded volcanics, through much of central Arizona and along the southern margin of the Colorado Plateau, indicate widespread crustal disturbance, uplift, and volcanism in the area during the late Miocene or early Pliocene (*4*). Concurrent deformations in southern Arizona are considered to have been "of mountain-building proportions" (*5*) and there seems to be good evidence that a major disturbance also raised the central Arizona upland locally, as at Prescott, higher than the Plateau blocks (*4*), which were also uplifted about this time (*6*).

Direct geologic evidence for determining the exact Mio-Pliocene altitude of the Prescott area, and of central Arizona in general, is lacking, but the information available strongly suggests at least moderate elevation, and a landscape locally dotted with mountains and volcanic cones possibly of sufficient height to support a montane forest. The Prescott microflora approximates today's foothill and slope vegetation (4000 to 5500 feet) of central and southeastern Arizona, corroborating, in part, the landscape configuration surmised from geologic evidence.

Oak chaparral and ponderosa pine forest are now the main vegetation types near the fossil site; pinyon-juniper woodland and grama grassland are prominent nearby. The relative abundance of components in a pollen rain derived from this vegetation is indicated in Table 1. The sediment analyzed (one of a series studied for this area) is a lake mud from the same elevation as the fossil site. Table 1 also shows the relative abundance of plants identified to date from the fossil pollen assemblage (*7*).

Except for elm, the identified fossils

Table 1. Frequency of components in fossil (Prescott) and modern (Granite Basin Lake) sediments. Plus mark indicates pollen seen on scan. (Some of those listed for the lake sediments were found only at adjacent localities, at elevations, in feet, shown in parentheses.)

Genus or family	Prescott microflora $N = 499$ (%)	Granite Basin Lake (5600 feet) $N = 631$ (%)
Arborescent pollen		
Quercus	23.8	33.1
Pinus	16.4	33.6
Juniperus-Cupressus	15.8	4.0
Juglans	0.6	2.5
Fraxinus	.4	+
Celtis	.2	+ (5400)
Alnus	+	+ (5500)
Betula	+	+
Ceanothus (*Rhamnus?*)	+	0.3
Ephedra	+	+ (5100)
Ulmus	+	+ (5400)
Agave		0.2
cf. *Garrya*		0.2
Opuntia		0.2
Vitis		0.2
Nonarborescent pollen		
Gramineae	10.8	2.5
Compositae	8.0	5.8
Artemisia (shrub?)	0.8	0.3
Chenopodiaceae-*Amaranthus*	5.2	1.3
Cyperaceae	1.0	2.5
Eriogonum (shrub?)	0.2	0.2
Malvaceae cf. *Sphaeralcea*	+	+
Polypodiaceae? (trilete spore)	+	+ (5100)
Typha	+	4.6
Plantago		1.7
Polygonum		0.6
Geranium (*Erodium?*)		0.2
Papilionoideae (shrub?)		0.2
Unknowns		
Tricolporites a	4.6	
Tricolpites a	2.4	
Other	10.4	6.1

(about 80 percent of the flora) are genera and families of the nearby vegetation, and all are represented by pollen in the recent sediments. The similarity between the fossil and living flora is consistent with, and tends to support, a late Tertiary age for the microflora. With regard to the pollen production of genera revealed by the recent pollen rains, pine in inferred to have been less common locally in the Mio-Pliocene vegetation than oak and juniper-cypress; its affinities, based on pollen size-frequency studies, are with the xeric *Pinus cembroides* (pinyon) group rather than the better-watered montane ponderosa pine.

Chaparral plants (other than oak?) are largely missing from the microflora. Most of them, however, are entomophilous, and few have shed pollen that has settled into contemporary sediments (Table 1). The more moisture-loving ash, walnut, and hackberry presumably thrived along washes and canyon bottoms, like their modern counterparts, throughout central and southeastern Arizona; two species of *Ephedra* evidently ranged into the wooded uplands, as do *E. trifurca* and *E. viridis* near Prescott.

Alnus, Betula, and *Ulmus* occur sporadically in the microflora, though it is believed that vegetational facies of the Madro-Tertiary geoflora completely controlled the southern Great Basin in the Mio-Pliocene (*8*). A more comprehensive record of these and other plants of presumed Arcto-Tertiary derivation has been obtained, also, from Mio-Pliocene sediments from coastal southern California (*9*). In all probability, the source of the Prescott pollen was a montane (conifer-deciduous hardwood) forest characteristic of the Arcto-Tertiary geoflora and in particular its West American element, many of whose living equivalents are found in the Rocky Mountain forest and its southern extension into uplands of northern and central Arizona. Single grains of alder and birch pollen in the recent sediments presumably were windborne 60 to 200 miles from the nearest stands of these genera. Elms reach their natural limits in Texas (Pecos River), though they survived in the Far West till at least the late Pliocene (*10*). Elm pollen has been recovered recently from possible Nebraskan pluvial sediments of southeastern Arizona (*11*), which suggests that the genus became extinct in the West only during the Pleistocene. Three species are cultivated at Prescott.

The microflora undoubtedly presents an incomplete spectrum of the herbaceous plants of late-Tertiary central Arizona. Nevertheless, a dimension is added to the vegetation that is scarcely hinted at in megafossil floras. Most of the herbs (Table 1) are seldom found fossil, or lack previous Tertiary records.

The microflora is characterized by the dominant woody genera of brushland and savanna-woodland of central and southeastern Arizona uplands, but lacks the common associated species which today give floristic entity to these communities, and includes some (as unknowns) which apparently do not now occur in these assemblages. Still, the similarity between the microflora and pollen rains from these contemporary communities is marked, although this likeness provides no proof of the stability of these plant associations through time. It is appropriate to question whether chaparral, conifer (juniper-pinyon) woodland, and encinal (oak-juniper-pinyon woodland) were differentiated as they now exist in Arizona (climatic conditions today favor their optimal development in different parts of the State), or whether the Tertiary vegetation was a "generalized" assemblage from which species composing these communities have been segregated because of climatic changes since the Mio-Pliocene, with regard to their varying tolerances and adaptabilities.

The microflora is at an elevation (5600 feet) where pine now largely dominates the vegetation of central Arizona. The relatively low frequency of fossil pine pollen in the flora implies that the basin of deposition was lower, or the climate was drier [average annual rainfall at Prescott (5355 feet) about 18 inches], or both, when the polliniferous sediments were deposited. The presence of birch, alder, and elm might appear to raise rather than lower the moisture requirements of the fossil flora, but their relative scarcity (in fossil and modern pollen rains) indicate distant transport from more mesic uplands (*12*).

JANE GRAY

Geochronology Laboratories, University of Arizona, Tucson

References and Notes

1. J. Gray, *Ariz. Geol. Soc. Digest,* in press.
2. J. F. Lance, personal communication.
3. C. A. Anderson and S. C. Creasey, *U.S. Geol. Survey Profess. Paper No. 308* (1958).
4. E. D. McKee, *Bull. Geol. Soc. Am.* **62**, 481 (1951).
5. M. M. Knechtel, *Am. J. Sci.*, ser. 5, **31**, 81 (1936).
6. C. R. Longwell, *Ibid.* **244**, 787 (1946).
7. A report on details of the occurrence and composition of the microflora is in preparation.
8. D. I. Axelrod, *Carnegie Inst. Washington Publ. No. 590* (1950).
9. J. Gray, "A Mio-Pliocene pollen diagram from southern California" (unpublished manuscript).
10. R. W. Brown, *J. Washington Acad. Sci.* **39**, 224 (1949); D. I. Axelrod, *Carnegie Inst. Washington Publ. No. 553*, 167 (1944).
11. J. Gray, unpublished manuscript.
12. This report is contribution No. 32, program in geochronology, University of Arizona, Tucson.

23 February 1960

Avian Uptake of Fission Products from an Area Contaminated by Low-Level Atomic Wastes

Abstract. Birds living on the Oak Ridge White Oak Lake bed, an area contaminated by low-level atomic wastes, revealed a striking seasonal difference in uptake of fission products. Because the omnivorous diet of passerine birds is ecologically comparable to the mixed diet of man, uptake of radionuclides by wild birds provides an assay of amounts to be expected at the trophic level of primary interest to man.

The fate of radioactive materials introduced into the environment must be understood before their effects on man and nature can be evaluated. It is particularly important to know what fraction of the total radioactivity entering the environment may be expected to reach successive trophic levels in the major types of ecosystems of the world. At Oak Ridge National Laboratory, the White Oak Lake basin is a waste disposal area in which a slowly fluctuating level of soil contamination occurs (*1*). Avian uptake from a given level of environmental contamination should indicate both the average and the maximum concentration of radionuclides to be expected at the trophic level of particular interest to man, since the seed-fruit-insect diet of a terrestrial bird population is similar, in an ecological sense, to the grain-fruit-meat diet of man. The present paper is concerned with gross beta radioactivity and with concentrations of Sr^{90} and Cs^{137} in birds living on the White Oak Lake bed in 1958–59.

From the ecological standpoint, White Oak Lake bed in 1958, three years after the lake itself had been drained, could be divided conveniently into two zones: an inner "bush" zone of sediments covered by vigorous growths of herbaceous plants, shrubs, and scattered clumps of willows; and an outer "thicket" zone representing the former lake margin, covered with dense growths of alder, pokeweed, and young trees. Summer birds, especially those breeding in the inner zone, were largely replaced by different species or different individuals (that is, "races") of the same species in winter.

Specimens were collected by means of Japanese mist nets, and dissected into several components: feathers, skin, muscle, viscera, eyes, and bone. Bone was separated from muscle by boiling, and the fluid was added to the muscle component. Radioassay of tissues, and of the birds' food, was accomplished by a wet digestion technique previously employed and described by Krumholz and Emmons (*2*). The procedure of Willard and Goodspeed (*3*), was used in the radiochemical analysis for Sr^{90}.

The Cs^{137} analysis employed was one modified by L. B. Farabee after Mizzan (*4*).

Gross beta radioactivities of the total biomass of breeding birds in the summer of 1958 are shown in Fig. 1. Since feathers and the contents of the gastrointestinal tract are not included, the values represent the radioactivity of beta-emitting radionuclides actually assimilated by the bird(s). For either maximum or average values, three orders of magnitude correlate with the known habitat selection of the species. Song sparrows (*Melospiza melodia*), field sparrows (*Spizella pusilla*), water thrushes (*Seiurus motacilla*), and chats (*Icteria virens*), which occupy the inner zone and feed close to the ground, exhibited the highest tissue levels; some individuals of these species approached 10^4 count/min per gram of wet tissue. In contrast, gross beta radioactivity was only about 1/10 as high in goldfinches (*Spinus tristis*) and indigo buntings (*Passerina cyanea*), birds which ranged between the tall and the low vegetation, and only about 1/20 as high in thicket birds such as catbirds (*Dumatella carolinensis*), white-eyed vireos (*Vireo griseus*), cardinals (*Richmondena cardinalis*), and Kentucky warblers (*Oporonis formosus*), which infrequently ranged into the inner zone. Tissues were scarcely above background in species such as the hummingbird (*Archilochus colubris*), which visited the lake bed only on periodic feeding excursions.

Gross beta radioactivity of feathers was quite variable, but high in some individuals (26,000 count/min per gram). Much of the feather radioactivity was the result of external contamination with soil and water, since most (but not all) of the radioactivity could be removed by thorough washings.

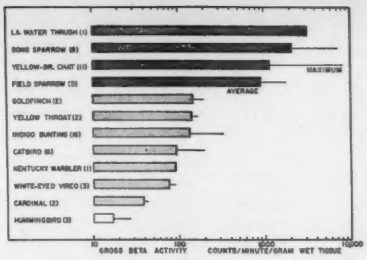


Fig. 1. Average (bars) and maximum (lines) gross beta activity of body tissues (exclusive of feathers and gastrointestinal tract) of species of birds living on the White Oak Lake basin during the summer of 1958. Species are arranged in a sequence from high to low average values. The first four species largely frequented the inner habitat zone, the next seven species nested largely in the outer shrub zone, while the hummingbirds only visited the basin to feed on nectar.

Table 1 compares radiostrontium in bone and radiocesium in muscle of birds from different habitat zones and seasons. The higher levels of inner- as compared with outer-zone birds, and the relatively large amounts of muscle Cs^{137} in winter are noteworthy. The winter specimens, which probably had not been living on the lake bed during the previous summer, were collected in March, so that body burdens presumedly were accumulated during the previous 2 or 3 months; summer birds were collected in July and August and probably had a similar time period (since arrival in April and May) for the accumulation of a body burden under conditions existing during the breeding season.

Table 2 shows the concentration of the two fission products in three food items which were commonly found in the stomachs of the birds collected in summer. Although less abundant in the soil, Sr^{90} concentration in fruit and insects was approximately equal to that of Cs^{137}. In birds, the final concentration of Sr^{90} in bone was about six times greater than that of Cs^{137} in muscle.

In winter the birds were feeding primarily on seeds. Only in winter did the birds have mud adhering to their bills, indicating that they were probing into the soft soil for seeds, and thereby ingesting soil. The concentration of Cs^{137} in muscle was extremely variable but quite high in one or two individuals, up to 19,000 $\mu\mu$c/gm (or almost 0.02 μc/gm). In view of the low Cs^{137} concentration in summer birds, these high winter values could have resulted only from direct ingestion of soil.

Table 3 summarizes the amount per acre of radiostrontium and radiocesium estimated to be present at different trophic levels at a given time in summer. Although the specific concentrations at the higher trophic levels were appreciable, the absolute amount of fission products actually reaching these levels was very small. The amount of radioactivity which might be removed permanently from the area by migrating birds is thus negligible.

The seasonal change in the Sr^{90}-Cs^{137} ratio in tissues strongly suggests that uptake by the bird population in summer was primarily through the food chain (chiefly via insects), while in winter appreciable uptake occurred by ingestion of contaminated soil.

In Table 4 the concentration of radiostrontium in birds of the White Oak Lake basin is compared with the present maximum permissible concentration for man and the observed concentrations in the bones of sheep and children resulting from world-wide fallout. These comparative data show that the average, and especially the maximum, levels in the birds are higher than we would want to risk in man. At present, it is not known whether these levels are actually harmful to the birds. In addition to the dose received by the internally deposited radionuclides, the birds living on the inner zone also receive continuous external gamma

Table 1. Comparison of specific activity (per gram wet tissue) of radiostrontium in bone and radiocesium in muscle of birds from different zones and seasons.

N	Sr^{90}–Y^{90} ($\mu\mu$c/gm)		Cs^{137} ($\mu\mu$c/gm)	
	Av.	Range	Av.	Range
	Summer, inner habitat zone			
6	302	13–595	50	11–102
	Summer, outer habitat zone			
8	68	17–160	22	3–62
	Winter, inner habitat zone			
7	229	0–1487	2801	43–18600

Table 2. Concentration (per gram fresh tissue) of radiostrontium and radiocesium in three important summer bird food items.

Sr^{90}–Y^{90} ($\mu\mu$c/gm)		Cs^{137} ($\mu\mu$c/gm)	
Av.	Range	Av.	Range
	Pokeberries (*Phytolacca*)		
9	7–10	6	4–9
	Blackberries (*Rubus*)		
8	7–9	3	2–4
	Beetles (*Carabidae*)		
108	87–121	90	80–105

Table 3. Estimated amounts (per acre) of Sr^{90} and Cs^{137} present at different trophic levels. Data pertain to White Oak Lake bed, Oak Ridge, Tennessee. Plant and soil data from Auerbach (*7*). Estimate for bird population based on data of Table 1 and a density of 20 birds per acre.

Trophic level	Sr^{90} (mc/acre)	Cs^{137} (mc/acre)
Birds	0.7×10^{-5}	1.9×10^{-5}
Plants	1.4	0.2
Soil	290	15000

Table 4. Comparison of Sr^{90} levels in calcium and bone with the maximum permissible concentration for man.

Items	Sr^{90} ($\mu\mu$c/gm Ca)	Sr^{90} ($\mu\mu$c/gm bone)
Maximum permissible concentration, man (*8*)	100–2000	25–250
Sheep in Wales 1956 (*9*)	160	57
Children 0–3 years of age, Northern Hemisphere, 1959 (*10*)	1.19	0.42
Oak Ridge birds:		
Average	700	172
Maximum	6000	1487

radiation (emanating from the lake bed) which varies from 10 to 50 mr/hr 1 m above the soil (*5*). Adults, eggs, and young of wild birds are now being subjected to controlled sublethal doses at the Atomic Energy Commission's Savannah River Plant to determine the effects, if any, which might be expected at various doses and at key stages in the life cycle (*6*).

WILLIAM K. WILLARD
University of Georgia, Athens

References and Notes

1. S. I. Auerbach and D. A. Crossley, *Proc. 2nd Intern. Conf. Peaceful Uses Atomic Energy*, Paper 401 (1958); E. R. Graham, *Soil Science* **86**, (1958).
2. L. A. Krumholz and A. H. Emmons, *J. Wildlife Management* **17**, 456 (1953).
3. H. H. Willard and E. W. Goodspeed, *Industrial Engineering Chemistry* (Analytical ed.), **8**, 414 (1936).
4. E. Mizzan, *Atomic Energy of Canada Ltd.*, Chalk River Project, PDB 128 (1954).
5. P. K. Lee and S. I. Auerbach, *Oak Ridge Natl. Lab. Rept.* (2755) (1959).
6. This study is a part of radioecological investigations supported by an Atomic Energy Commission grant, contract At (-07-2)-10 with the University of Georgia, and is a joint contribution with the Health Physics Division, Oak Ridge National Laboratory, operated by Union Carbide Corporation for the United States Atomic Energy Commission. I am indebted to Dr. E. P. Odum, University of Georgia, and Dr. S. I. Auerbach and Dr. L. R. Farabee, Oak Ridge National Laboratory, for suggestions and technical assistance.
7. S. I. Auerbach, *Health Physics Ann. Prog. Rept., Oak Ridge Natl. Lab.* (2806) (1959).
8. Since a variety of opinions exist on the maximum permissible concentration for man, a range is given; see R. Bjornerstedt, *Science* **129**, 327 (1959).
9. F. J. Bryant, A. C. Chamberlain, A. Morgan, C. S. Spicer, *J. Nuclear Energy* **6**, 22 (1957).
10. J. L. Kulp, A. R. Schulert, E. J. Hodges, *Science* **129**, 1249 (1959).

9 February 1960

Antiozonants To Protect Plants from Ozone Damage

Abstract. Manganous 1,2-naphthoquinone-2-oxime protected tomato foliage in the field from damage apparently caused by excessive atmospheric ozone. The compound proved to be a very effective antiozonant. The similar cobaltous and manganous chelates of 8-quinolinol were also effective antiozonants. The materials were applied to cloth of the type used to make field tents for shade-grown tobacco. Tomato plants covered with cloth treated with cobaltous 8-quinolinolate were protected against otherwise damaging concentrations of ozone. These materials and methods may afford a useful way to reduce weather fleck of tobacco and other plant injuries caused by excessive atmospheric ozone.

Crop damage from excessive atmospheric ozone is becoming a serious problem throughout the country. Two of the best known examples of ozone damage are stipple of grape in southern California (*1*) and weather fleck of tobacco in Connecticut and Massachusetts (*2*). In New Jersey, ozone damage has been observed on spinach, alfalfa, cereals, red clover, beans, parsley, and grapes (*3*). Recently, Ledbetter *et al.* (*4*) demonstrated that many species of common plants can be readily injured by exposure to ozone.

During 1959, a wide variety of plants in Connecticut, such as tomatoes, potatoes, apples, and many kinds of weeds, showed severe damage after a weather period which resulted in serious fleck on tobacco. The type of injury on the various plants and its coincidence with the appearance of fleck on tobacco indicated that ozone was the damaging agent.

During this period we observed that tomato plants sprayed with a trial fungicide, manganous 1,2-naphthoquinone-2-oxime (*5*), were much less injured than were other tomato plants in the same plot. This suggested that the experimental fungicide is an effective antiozonant. The structural similarity of this compound to 8-quinolinol suggests the possible antiozonant action of the manganous and the cobaltous 8-quinolinolate. The antiozonant action of these compounds was determined experimentally, together with that of diphenyl-*p*-phenylenediamine and other compounds which are used in the rubber industry as antiozonants.

Because these materials have not been thoroughly tested on plants, it became of practical interest to see whether plants could be protected from ozone by covering the plants with standard tobacco shade cloth treated with the compounds.

The testing equipment consisted of an ozone-producing chamber, a gassing chamber, and ozone-measuring meters. Two different ozone-producing chambers were used. Both were glass boxes containing ultraviolet lamps. One box had four "Odor Out" Westinghouse bulbs, producing a total of 0.08 gm of ozone per hour. The other box, for greater ozone production, enclosed a Rayonet Superkill fixture with two high-ozone lamps, producing 2 gm of ozone per hour at full voltage. The ozone-laden air was pumped into either a glass-enclosed gassing chamber for exposing plants or cellophane bags for measuring the antiozonant effect of treated cloth strips. The ozone level in the chamber or bags was measured with a Mast portable atmospheric ozone recorder (model 724-1).

A strip of shade tent cloth dusted with a 25-percent formulation of manganous 1,2-naphthoquinone-2-oxime was sealed into a cellophane bag continuously supplied with ozone. The treated cloth reduced the ozone level from 0.7 to less than 0.1 part per million and held it at the lower level for 24 hours. Other test cloths were prepared as follows: they were dipped into chloroform solutions of 8-quinolinol, air-dried, then dipped into water solutions of the appropriate metal salt to form the chelate complex on the cloth. The cloths were air-dried again. The final weight of compound was 405 mg/m² of cloth. Both 8-quinolinolates proved to be good antiozonants, the cobaltous complex being more effective than the manganous complex.

Compounds used as antiozonants in the rubber industry were tested in the same manner as the 8-quinolinolates and proved to be even more effective. Table 1 compares the antiozonant action of the more effective materials with that of zinc ethylenebis(dithiocarbamate). The latter compound is now used in agriculture to protect crops against atmospheric ozone. The data from Table 1 show that the dialkyl-*p*-phenylenediamines and nickel di-N-butyldithiocarbamate are much more effective as antiozonants than is zinc ethylenebis(dithiocarbamate).

Can treated shade cloth protect plants against ozone damage? Young tomato plants covered with untreated shade cloth and gassed with ozone (0.8 part per million) for 4½ hours were severely damaged. Another set of tomato plants covered with tobacco shade cloth treated with cobaltous 8-quinolinolate showed practically no injury after 4½ hours in the ozone gassing chamber.

In tobacco fields, shade cloth treated with these materials may well reduce weather fleck to a considerable extent, although this has not been determined as yet. Because these materials are quite insoluble in water, cloth treated with them should be highly resistant to weathering. The use of catalytic antiozonants, such as nickel di-N-

Table 1. The antiozonant effect of cloth treated with antiozonants used in the rubber industry as compared with that of a cloth treated with zinc ethylenebis(dithiocarbamate), a material now used to protect crops against ozone. The cloths were tested in a chamber constantly gassed with ozone (0.4 to 0.7 part per million).

Lowest reading (in parts of ozone per million) after treated cloth was placed in chamber	Time chamber was held at lowest reading by cloth (hr)
Nickel di-N-butyldithiocarbamate	
0	67
N-Isopropyl-N'-phenyl-p-phenylenediamine	
0	18
N,N'-Di-sec-octyl-p-phenylenediamine	
0.01	12
Zinc ethylenebis(dithiocarbamate)	
0.06	0.5

butyldithiocarbamate, applied either to cloth covers or directly to plants, eventually may be useful to protect crops other than tobacco from ozone damage (*6*).

SAUL RICH
GORDON S. TAYLOR
Connecticut Agricultural Experiment Station, New Haven

References and Notes

1. B. L. Richards, J. T. Middleton, W. B. Hewitt, *Agron. J.* **50**, 559 (1958).
2. H. E. Heggestad and J. T. Middleton, *Science* **129**, 208 (1959).
3. Anon., *New Jersey Agr.* **42**, 3 (1960).
4. M. C. Ledbetter, P. W. Zimmerman, A. E. Hitchcock, *Contribs. Boyce Thompson Inst.* **20**, 275 (1959).
5. The fungicide (EF 35,429) was obtained from American Cyanamid Co., Stamford, Conn.
6. Samples of the compounds used in this study were obtained from American Cyanamid Co., Stamford, Conn.; Eastman Chemical Products, Inc., Kingsport, Tenn.; U.S. Rubber Co., Naugatuck, Conn.; and R. T. Vanderbilt Co., New York, N.Y.

28 March 1960

Serial Lactic Dehydrogenase Activity in Plasma of Mice with Growing or Regressing Tumors

Abstract. Close correlation has been observed between the serially tested plasma level of a glycolytic enzyme, lactic dehydrogenase, and the growth of several transplanted mouse tumors. The character of the lactic dehydrogenase curve determined by serial blood sampling of the animals during the development of such tumors is found to consist of five separate phases. The first three appear before any visible evidence of tumor growth. Inhibition or regression of tested tumors, induced by therapeutic compounds, was accurately reflected in a corresponding reduction of lactic dehydrogenase activity in the peripheral plasma of the host.

Lactic dehydrogenase activity has been found to be elevated in the serum or plasma of animals with various experimental tumors, and in some patients with malignant neoplasia (*1–3*). It is also increased in the serous effusions that bathe cancer tissue in human beings, and in the media surrounding various malignant cell lines in tissue culture (*2*, *3*).

The serial assay of this enzyme in the blood plasma of mice during the growth of such diverse transplanted tumors as Ehrlich solid carcinoma, sarcoma T-241, mammary adenocarcinoma E-0771, or the Cloudman S91 melanoma shows a close correlation between increasing tumor mass and the progressive elevation of lactic dehydrogenase activity in the peripheral blood. This confirms and elaborates earlier observations of elevation of this enzyme in the serum or plasma of tumor-bearing animals (*1–3*). In addition to an overall correlation of enzyme activity and tumor volume, five phases of the lactic dehydrogenase time curve have been observed, as illustrated in Fig. 1: (i) a latent period between tumor implantation and initial appearance of elevated levels of enzyme in the plasma lasting 24 to 96 hours, depending upon the tumor type and its growth rate; (ii) a rapid increase of the enzyme activity from normal values (approximately 500) to 2000 to 6000, giving a 5- to 10-fold enzyme increase prior to detectable growth of tumor implant (this increase takes place usually during the 2nd or 3rd day after implantation); (iii) a plateau following the initial increase and remaining essentially level for several days; (iv) a second rapid increase in plasma enzyme closely correlated with the logarithmic growth phase of the tumor, but usually initiated prior to measurable growth of the new tumor mass. Such an enzyme increase continues with growth of the tumor up to values of 25,000 to 50,000 units—an increase over normal enzyme values of 50- to 100-fold. The final phase (v) frequently observed is an abrupt fall in enzyme level in the plasma just prior to the death of the tumor-bearing animal. Such a fall has also been seen in terminal cancer patients (*2*). Although Fig. 1 is diagrammatic, it accurately represents the composite data for the control mice in 20 individual experiments. The lactic dehydrogenase activity curve was derived from 707 individual enzyme determinations on 163 untreated Swiss ICR mice implanted subcutaneously with the Ehrlich carcinoma. The bleeding was done serially on the same animals by a modification of the orbital bleeding technique (*4*). The plasma enzyme was assayed by a microtechnique modification of a spectrophotometric procedure described previously (*5*). The tumor growth curve in Fig. 1 is an expression of the average tumor volume, with time, determined by a total of 1172 three-dimensional caliper measurements on the solid Ehrlich carcinomas of these mice, taken from the palpable appearance of the lesion to the death of the animal.

Appropriate correlative alterations of the lactic dehydrogenase activity curve occur when the growth of the tumor is modified by various antitumor compounds. Figure 2 illustrates the development and regression of an Ehrlich carcinoma implanted in an animal undergoing treatment with orthophenylenediamine (*6*) and indicates the corresponding increase and decrease of the enzyme activity in the blood plasma as a function of tumor behavior.

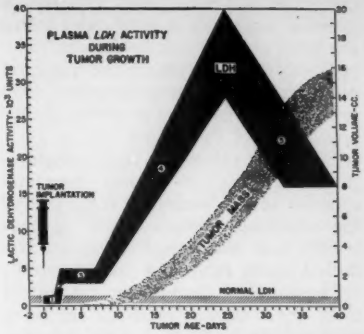


Fig. 1. Correlation of increasing lactic dehydrogenase activity (LDH) in plasma with progressive growth of the solid Ehrlich carcinoma, and illustration of five distinct phases of the enzyme response curve.

The first three phases do not show in this plot since the lactic dehydrogenase determinations were not started until the 4th day following tumor implant, at which time the phase (iii) plateau had already been reached. The data of Fig. 2 were obtained from a single mouse and illustrate the possibility of serial accumulation of enzyme information with these techniques on individual experimental animals, analogous to the close clinical following of a patient.

Although the tumor regressed completely in this experiment and the animal remained tumor free during several months of subsequent observation, the enzyme activity never returned to a completely normal level. This has been confirmed in several experiments in which the enzyme activities in the plasma of mice with regressed tumors slowly approach normal levels after the original precipitous decrease, but never-

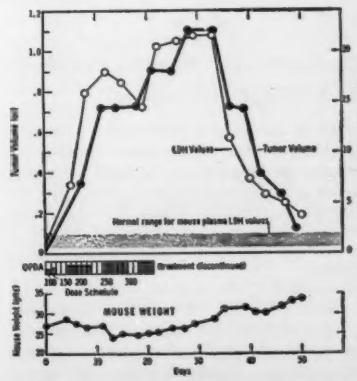


Fig. 2. Growth and regression of a treated Ehrlich carcinoma and the corresponding plasma levels of lactic dehydrogenase activity (LDH).

theless remain significantly elevated for periods of at least 1 year. This postregression plateau is in most cases within the 2000 to 6000 unit level, which corresponds quantitatively to the first host-response plateau seen shortly after tumor implantation but prior to the appearance of the tumor.

Since the values for lactic dehydrogenase activity in plasma have responded to the successful treatment of the established tumors which we have tested, and since they have also reflected tumor inhibition prior to visible or measurable changes in the tumor mass, these enzyme methods are being explored to determine their potential usefulness as additional indices in the screening of antitumor compounds and of extending the understanding of tumor-host-enzyme relationships (*7*).

VERNON RILEY
FELIX WROBLEWSKI
Divisions of Experimental Chemotherapy and *Clinical Investigation, Sloan-Kettering Institute for Cancer Research, New York, New York*

References and Notes

1. B. R. Hill, and C. Levi, *Cancer Research* **14**, 513 (1954); K. M. Hsieh, V. Suntzeff, E. V. Cowdry, *ibid.* **16**, 237 (1956); C. Manso, K. Sugiura, F. Wroblewski, *ibid.* **18**, 682 (1958); V. Riley and F. Wroblewski, *Federation Proc.* **18**, 310 (1959).
2. F. Wroblewski, *Cancer* **12**, 27 (1959).
3. A. E. Moore and F. Wroblewski, *Proc. Soc. Exptl. Biol. Med.* **98**, 782 (1958).
4. V. Riley, in preparation.
5. F. Wroblewski and J. S. LaDue, *Proc. Soc. Exptl. Biol. Med.* **90**, 210 (1955); O. Warburg, *Die Wasserstoffübertragenden Fermente* (Saenger, Berlin, 1948).
6. V. Riley, *ibid.* **100**, 155 (1959); *"The Melanoma* as a Model in a Rational Chemotherapy Study," in *Pigment Cell Biology* (Academic Press, New York, 1959), pp. 389–433.
7. We are deeply indebted to Editha Huerto, Carol Ross, David Bardell, and Frank Lilly for their assistance in these studies, and to Henry Abrahams, Alan F. Arnold, Marie Bunker, Eleanor Havesi, and Claude Arpels of the Sloan-Kettering Institute Volunteer Department. We also wish to thank C. Chester Stock for support and counsel.

21 March 1960

Communicative Mandible-Snapping in Acrididae (Orthoptera)

Abstract. *Paratylotropidia brunneri* Scudder is the first insect known to possess a long-range mandibular sound signal. This signal probably evolved through a stage in which feeding noises were significant; it is believed to be a functional analog of other insect calling sounds.

Many insects with chewing mouthparts make audible noises while feeding, but only among the short-horned grasshoppers are cases known in which sounds made by movements of the empty mandibles operate as intraspecific communicative signals. This ability has appeared in scattered genera in three subfamilies of Acrididae: Acridinae, Oedipodinae, and Cyrtacanthacridinae (*1*, *2*). In most cases the sounds appear to be no more than relatively nonspecific reactions to disturbances, produced by nymphs and adults of both sexes when they contact one another or when they are disturbed by the activities of other animals. However, in *Calliptamus italicus* (L.) (Cyrtacanthacridinae), several mandibular noises occur as significant signals in situations similar to those which are regulated by tegmino-femoral stridulation in the Acridinae and Oedipodinae. Mandibular sounds are produced by adults of both sexes when they are disturbed, and by males during aggressive encounters with other males, during courtship, when courtship is interrupted, and during copulation (*2*,*3*). The single finding that keeps this series of situations from paralleling those in which tegmino-femoral stidulation is significant in Acridinae and Oedipodinae is that *C. italicus* has no calling sound—no signal produced by lone males in the absence of other individuals which results in the coming together of the sexes or has any of the other side effects of this signal in various Orthoptera and Homoptera (see *4*).

On 20 June 1959 I tape-recorded a mandible-snapping noise made by *Paratylotropidia brunneri* Scudder (Cyrtacanthacridinae), which is not only the first sound recorded for this species but also appears to represent a close parallel of the calling sound in other Orthoptera and in Homoptera. This large grasshopper was abundant in a hill prairie along the crest of the Mississippi River bluff south of Valmeyer, Ill., in Monroe County. A similar prairie just south of this one has been described and illustrated (*5*). The dominant plant is *Andropogon scoparius* Michx.; there are occasional clumps of *A. gerardi* Vitman present, along with several other native prairie plants and animals. During the day in late spring and early summer, the principal sounds in the prairie are the calling songs of three Acridinae: *Chloealtis conspersa* Harris, *Pseudopomala brachyptera* (Scudder), *and Eritettix simplex* (Scudder) (*6*). The tiny grassland cicada, *Beameria venosa* (Uhler), and three largely nocturnal crickets, *Acheta fultoni* Alexander, *Miogryllus verticalis* (Serville), and *Oecanthus argentinus* Saussure, were the only other singing insects heard in the prairie on three separate visits at this time of year. This is perhaps the only habitat in eastern North America in which slant-faced grasshoppers are at any time the dominant noisemakers.

Several *Paratylotropidia brunneri* were collected before it was discovered that series of soft ticks heard almost continually here and there across the prairie were being produced by this species. A male was approached and watched as he made the noise; his mandibles could be seen moving in time with the sound. Individuals spaced a few feet apart seemed to be responding to one another by repeating series of ticks in rapid succession, each one beginning about a second after his nearest neighbor had finished. My attempts to get a response by tapping various metal objects together were unsuccessful until finally a nearby male delivered a series of ticks immediately following an imitation made by striking a metal thermometer case against a brass belt buckle. In each of many subsequent trials, the insect responded to the imitation after an interval of about 1 second (0.9 to 1.0 second in five tape-recorded trials). This was the same interval as was occurring between successive series of ticks by neighboring grasshoppers, and an irregular juggling of the time of delivery of the imitation left no doubt that the grasshopper was responding to it.

The mandible-snapping of *Paratylotropidia brunneri* is a simple sound, resembling a low-intensity abbreviated version of the ticking song of the katydid, *Microcentrum rhombifolium* (Saussure) (*4*). It is audible from a distance of several yards. Audiospectrographic analysis shows that the ticks have a nearly continuous frequency spectrum up to at least 15 kcy/sec, with intensity peaks at about 3, 5, and 8 kcy/sec. The ticks are delivered at rates of 6 to 7 per second (*7*); of 16 tape-recorded series, 12 series were comprised of 4 ticks each, and the other four, of 2, 3, 5, and 6 ticks each (*8*).

Every aspect of this observation suggests that the ticking of *P. brunneri*—produced by lone males and elicited consistently by auditory stimuli—is functionally analogous to the calling songs already known for Acridoidea, Tettigonioidea, and Auchenorhynchous Homoptera. This is a significant addition to our knowledge of insect acoustics, representing another instance of parallel evolution in the development of long-range sound signals. Further observation on this species is likely to reveal that mandibular sounds function in several situations, as they do in *Calliptamus italicus*.

Communicative mandible-snapping has probably evolved in every case through a stage in which the noise made by feeding grasshoppers was the initial auditory stimulus. Visually significant motion of the mandibles seems a less likely precursor, though it may have appeared as an intermediate stage in some cases; Acrididae are generally most active in bright sunlight, and vision is important in their close-range behavioral interactions. Lépiney (*9*) has shown that the odor of crushed leaves acts as an attractant to migratory lo-

custs, and this could have been a precursory stage to aggregation through response to feeding noises.

The mandibles of *Paratylotropidia brunneri* show no special modification indicative of a role in sound production. Because of the importance of mandibular structure in feeding, it seems unlikely that mandibular sounds could ever become as extensively elaborated as the tegminal and tegminofemoral stridulations of other Orthoptera. It is probably significant that *P. brunneri* occurs in a habitat where there are few other sound-producing insects, and where a soft, simple sound is more likely to become an effective long-range signal.

RICHARD D. ALEXANDER
Museum of Zoology and
Department of Zoology,
University of Michigan, Ann Arbor

References and Notes

1. D. K. M. Kevan, "L'Acoustique des Orthoptères," *Ann. inst. natl. recherche agron. Sér. A* (1954), pt. C, pp. 103–141; bibliog.
2. A. Faber, *Laut- und Gebärdensprache bei Insekten* (Stuttgart, Germany, 1953).
3. ———, *Z. Naturforsch.* **46**, pt. b, 367 (1949).
4. R. D. Alexander, "Animal Sounds and Communication," *Am. Inst. Biol. Sci. Publ.*, in press.
5. R. A. Evers, *Illinois Nat. Hist. Survey Bull.* **26**, 367 (1955).
6. I am indebted to Dr. I. J. Cantrall for aid in identification of these grasshoppers.
7. The temperature was 93°F 2 feet above the ground in sunlight.
8. The specimens and tape recordings are located in the University of Michigan Museum of Zoology. Sounds were recorded with a Magnemite tape recorder, model 610-E (tape speed, 15 in. per second), with an American Dynamic D-33A microphone, held 6 to 10 in. from the insect.
9. J. de Lépiney, *Compt. rend. soc. biol.* **104**, 263 (1930).

23 March 1960

Dialysis of Certain Sugars through Cellophane

Abstract. Of several sugars examined, alkali most affects the rate of dialysis through cellophane of alpha-beta-D-mannose and alpha-beta-maltose. The rates of dialysis of these two sugars are influenced by 0.01 and 0.1*N* solutions of sodium and potassium hydroxide. The rate of dialysis of sucrose is not influenced by the solutions employed.

During applications of the procedure of Craig (*1*, *2*) for the selective dialysis of solutes, it was observed (*3*) that changes in chemical environment affect the rates of dialysis through cellophane of certain sugars more than the rates of others. Particularly clear was the effect of hydroxyl ion on the dialysis rate of some sugars. Since the effects could be reversed by neutralizing the alkali, chemical degradation of the carbohydrate could not account for the observations.

Seven milliliters of a 0.2- to 0.4-percent sugar (reagent grade) solution known to be at equilibrium with respect to the alpha and beta anomers were dialyzed through cellophane (19 mm diameter when round, No. 10886, Will Corporation) into 70 ml of the indicated solvent at room temperature. Every effort was made throughout to keep the dialyzing surface at approximately 52 cm². The procedure outlined by Craig (*2*) was employed. The selected time for dialysis, 45 minutes, was the approximate half escape time for most of the sugar solutions. All analyses were by means of the *o*-aminobiphenyl procedure (*4*). An analysis was considered satisfactory when the total sugar calculated from the concentration of the 70-ml dialyzate and the 7-ml bag contents agreed with the total sugar calculated from the measurement of the concentration of the original solution. Values in Table 1 are differences obtained by substracting the percentage of sugar remaining in the dialysis bag after 45 minutes in the indicated solvent from the corresponding value when water was the solvent. For example: at 45 minutes 41.8 percent of D-mannose remained when dialyzed in water, while 70.8 percent remained when the solvent was dialyzed in 0.10*N* sodium hydroxide. The difference, 29, appears in Table 1. For this same sugar placed in 0.1*N* sodium hydroxide for 45 minutes, neutralized with HCl and dialyzed, the percentage remaining was 43.1, a value sufficiently different from the value obtained when dialyzed in sodium hydroxide that the cause for the difference between rates in alkali and water could not be deterioration of the sugar in sodium hydroxide. Percent remaining values represented mean values which for three determinations would differ by no more than 4.5 percent of the mean. The analysis, as would be expected, for a sugar showed a smaller deviation. For example, when 300 μg of glucose were measured in ten trials, the mean for the ten observations was 299.6 and the standard deviation was 6.3.

To further test the reliability of the measurement of the observed dialysis rates, a hexose mixed with pentose was dialyzed with water as the solvent. The sugars remaining in the cellophane bag after dialysis were chromatographically separated (*5*) and the relative quantities of sugar found were compared with the relative quantities of the sugars in the original solution of the mixed pair before dialysis.

When D-glucose and D-arabinose were dialyzed mixed, the absorbance ratios of the *o*-aminobiphenyl derivatives of the chromatographically separated sugars agreed within 1 percent with the ratios of the optical densities such derivatives of the sugars separately dialyzed.

The date of Table 1 indicate that the dialysis rates of D-mannose, D-arabinose, maltose, and cellobiose are most affected by 0.1*N* sodium hydroxide. Of these four sugars, all but D-arabinose are affected by 0.01*N* sodium hydroxide. The dialysis rates of D-mannose and maltose are most affected in both concentrations of sodium hydroxide. Increasing the concentration of sodium hydroxide from 0.1*N* to 0.5*N* (not shown in Table 1) did not increase the effect of sodium hydroxide on mannose (rate in 0.5*N* sodium hydroxide minus rate in water was 26.4). How significant an increase the corresponding difference for maltose, 25.2 in 0.5*N* sodium hydroxide, is over the value in 0.1*N* sodium hydroxide (20.7 in Table 1) is not decided by these data. The data show that 0.01*N* potassium hydroxide has a greater affect on the dialysis rate of maltose than does sodium hydroxide of comparable concentration. The dialysis rates of D-mannose and maltose were not changed by increasing the concentration of potassium hydroxide from 0.01 to 0.1*N*.

Table 1. Comparison of rates of dialysis of certain sugars in water and alkaline solutions. The values shown are the rate of dialysis in alkaline solution minus rate in water.

Sugar	Alkaline concentration	
	0.01*N*	0.10*N*
	Sodium hydroxide solution	
D-Glucose	3.2	9.1
D-Galactose	4.1	10.4
D-Mannose	11.4	29.0
D-Arabinose	2.2	18.3
L-Arabinose	0.1	10.3
D-Xylose	1.9	5.3
L-Xylose	3.5	11.5
Sucrose	0	3.6
Maltose	12.0	20.7
Cellobiose	10.2	15.1
	Potassium hydroxide solution	
D-Glucose	0.8	9.5
D-Mannose	12.8	12.7
D-Arabinose	6.7	12.8
D-Maltose	18.2	17.8

The sugars D-mannose and maltose, the dialysis rates of which are most affected by the changes in chemical environment examined above, are considered "alkali sensitive" by Reeves (*6*), when optical rotation is the index (*6*). Changes in conformation of the sugars, claimed for the effect of alkali on optical rotation (*6*), cannot explain here the failure of sucrose to dialyze at a lower rate than that observed. By the same reasoning, cellobiose would be expected to dialyze more rapidly than it did here. It is unlikely that the alkali effect observed here in dialysis could be attributed entirely to the influence of the hydroxyl ion on the equilibrium between the alpha and beta forms of the sugars. If influence on mutarotation were the explanation, one would presume that glucose, maltose, and cellobiose might be similarly influenced, since each has the same percentage (*7*) of

alpha and beta forms at mutarotation equilibrium in water. On the other hand, the behavior of sucrose would support the view that the effects observed here are due to events involving the anomeric carbon.

MALCOLM B. TEMPLEMAN
LAWRENCE M. MARSHALL
Department of Biochemistry, Howard University College of Medicine, Washington, D.C.

References and Notes

1. L. C. Craig and T. P. King, *J. Am. Chem. Soc.* **77**, 6620 (1955).
2. L. C. Craig, T. P. King, A Stracher, *ibid.* **79**, 3729 (1957).
3. This work was supported in part by a grant from the National Science Foundation and the National Institutes of Health.
4. T. E. Timell, C. P. J. Glaudemans, A. L. Currie, *Anal. Chem.* **28**, 1916 (1956).
5. D. F. Durso and W. A. Mueller, *J. Am. Chem. Soc.* **78**, 1366 (1956).
6. R. E. Reeves, *Am. J. Physiol.* **79**, 2261 (1957).
7. R. Bentley, *J. Am. Chem. Soc.* **81**, 1952 (1959).

18 March 1960

Contribution of Hardtack Debris to Contamination of the Air during 1959

Abstract. A comparison of the concentrations of tungsten-185 and strontium-90 in the air at various times after the 1958 U.S. nuclear tests in the Pacific indicates that debris from this test series contributed less than 10 percent of the total Sr^{90} content of the ground-level air at Miami and Washington during the spring of 1959.

The detection at sites along the 80th meridian (west) of W^{185} produced uniquely in the U.S. Hardtack series of nuclear tests at the Pacific Proving Grounds in 1958 showed the rapidity with which radioactive debris could be disseminated by atmospheric processes (*1*). By making certain assumptions regarding the relative amounts of W^{185} and Sr^{90} produced during these tests, the quantitative determination of these isotopes at later times can lead to a rough estimation of the contribution of Sr^{90} from Hardtack to the total Sr^{90} in a given sample.

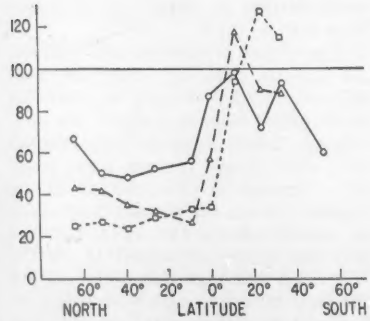


Fig. 1. Latitudinal variation in the W^{185}/Sr^{90} activity ratio. Vertical axis describes the ratio, W^{185} corrected for decay to 15 July 1958. Circles, January readings; triangles, March readings; squares, May readings.

Radiochemical analyses of debris from the Hardtack test series indicated a possible value of 1000 to 1200 for the W^{185}/Sr^{90} activity ratio of the tungsten-containing shots (*2*). If it is assumed that this value is typical of all the tungsten-containing shots, and, furthermore, that one-half the total fission yield of the series resulted from shots of this nature, a W^{185}/Sr^{90} activity ratio of near 500 is obtained as a reasonable characterization of this series. Thus, airborne debris in filter collections made at various sites during 1959, upon radiochemical analysis for W^{185} and Sr^{90}, and with suitable decay corrections, can be assigned to Hardtack or non-Hardtack nuclear tests. Some data on the measured air concentrations of W^{185} and Sr^{90} at several sites along the 80th meridian are listed in Table 1.

As may be seen in Fig. 1, the W^{185}/Sr^{90} activity ratio varies with latitude and with time. This ratio is considerably lower in the Northern than in the Southern Hemisphere—about one-half to two-thirds as high in January 1959 and only about one-fourth as high in May, during the time of peak air activity from the previous series of nuclear tests, by the U.S.S.R., in the Arctic (October–November 1958).

Simple calculations indicate that during May 1959 only about 5 percent of the Sr^{90} activity in the North Temperate Zone, along the 80th meridian, originated in the U.S. Hardtack tests. During earlier and later periods, when radioactivity from the U.S.S.R. tests was not so prevalent in the ground-level air, Hardtack debris contributed perhaps 10 percent of the total Sr^{90} (Table 2). In the Southern Hemisphere during early 1959, while the actual W^{185} concentration in the air was only one-quarter that in the Northern Hemisphere, the Hardtack series contributed nearly 20 percent of the total airborne Sr^{90}. This points up the fact that the stratospheric burden of debris both from Hardtack and from other nuclear test series is considerably lower in the Southern than in the Northern Hemisphere. Furthermore, it is evidence that the transequatorial mixing process in the stratosphere, as in the troposphere, is a relatively slow one.

Table 1. Air concentrations of W^{185} and Sr^{90} at several sites along the 80th meridian (W^{185} corrected for decay to 15 July 1958). Activity is registered in disintegrations per minute per 100 standard cubic meters.

Washington		Miami		Antofagasta	
Sr^{90}	W^{185}	Sr^{90}	W^{185}	Sr^{90}	W^{185}
		July 1958			
2.9	53	1.5	43	0.88	46
		September 1958			
1.6	179	1.2	186	1.3	77
		November 1958			
2.4	222	2.2	193	0.69	60
		January 1959			
5.7	274	5.9	308	1.01	73
		March 1959			
6.6	234	10.4	330	0.41	37
		May 1959			
9.0	214	6.7	198	0.30	38
		July 1959			
2.7	98	1.4	73		

Table 2. Contribution of Hardtack Sr^{90} to total Sr^{90} in the air, expressed as percentage.

Total Northern Hemisphere	Washington (39°N)	Miami (26°N)	Antofagasta (24°S)	Total Southern Hemisphere
		July 1958		
4.7	4	6	10	12
		September 1958		
	22	31	12	
		November 1958		
	19	18	17	
		January 1959		
10.7	9.6	10.4	14.5	17.5
		March 1959		
7.0	7.1	6.4	18.0	
		May 1959		
5.5	4.8	5.9	25	18.2
		July 1959		
8.5	7.3	10.4		

The usefulness of W^{185} (74-day half-life) as a tracer for Hardtack debris is rapidly nearing an end because of the isotope's depletion through radioactive decay (*3*).

L. B. LOCKHART, JR.
R. L. PATTERSON, JR.
A. W. SAUNDERS, JR.
R. W. BLACK
U. S. Naval Research Laboratory, Washington, D.C.

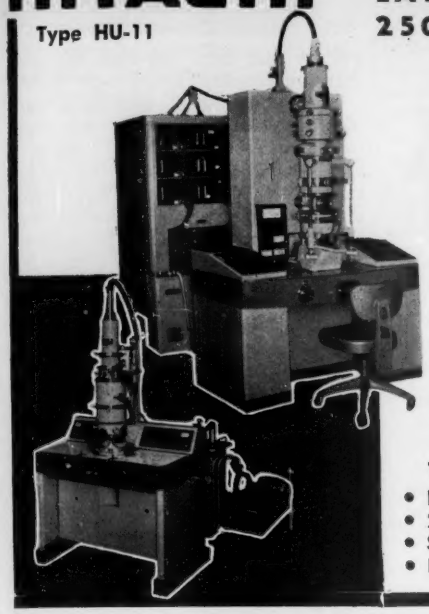
References

1. L. B. Lockhart, Jr., R. A. Baus, R. L. Patterson, Jr., A. W. Saunders, Jr., *Science* **130**, 161 (1959).
2. ———, *U.S. Naval Research Lab. Rept. No. 5390* (Oct. 1959).
3. Partial financial support for this work was obtained from the U.S. Atomic Energy Commission.

10 March 1960

HITACHI

Type HU-11



LATEST ELECTRON MICROSCOPE PERMITS 250,000 TIMES DIRECT MAGNIFICATION!

Hitachi, Ltd. which has been supplying electron miscroscopes to scientific institutes and laboratories around the world, has now developed the new Model HU-11, a unit featuring extremely high resolving power. This is considerably less than 8AU, tending to distinguish it as a remarkable item of equipment by contemporary standards.

Hitachi's unique chromatic aberration compensating lens system has been further improved and a new electron gun provides a brighter illumination, allowing the photography of high order diffraction pattern.

• Accelerating voltage	100, 75 and 50kV switch-over
• Optical system	3-stage magnetic lens system. 4 turret projection lenses, interchangeable during operation.
• Illuminating system	Self-biased gun with double condenser lenses. Minimum area of illumination of about 5μ^2
• Magnification	(Electronic) 400—250,000 X (Photographic Enlargement) up to 2,000,000 X
• Resolving Power (Microscope)	8 AU
• Photographic Facilities	36 successive exposures exposure size: 8cm x 6cm
• Accessories	specimen heating and cooling devices. X-ray microscope unit, holder for diffraction observation, etc.

Type HS-6

- Permanent magnet lens system
- 20 AU resolution
- Suitable for medical purposes
- Easy operation

Erb & Gray Scientific, Inc.
854 S. Figueroa St., Los Angeles 17, Calif.

Hitachi, Ltd.
Tokyo Japan

Cable Address: "HITACHY" TOKYO

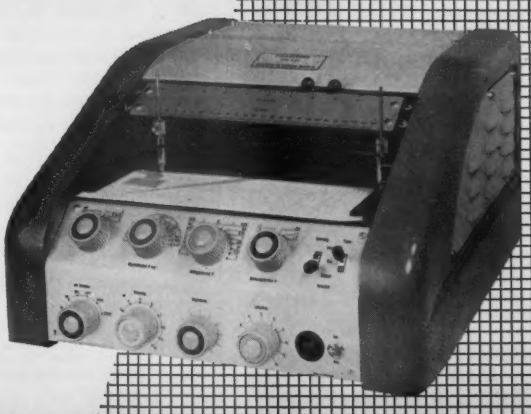
METROHM

NEW! *RAPID* POLAROGRAPHY

A major disadvantage of polarographic methods, especially in industrial laboratories, has been the considerable time used to run a complete test (polarogram). A minimum time of from five to fifteen minutes is required with all DC polarographic recorders currently available from commercial sources, both here and abroad. These delays result from the dropping time of the mecury electrode which should be in intervals of two to five seconds in order to obtain a sufficient number of measuring points.

Recent experiments at the METROHM laboratories in Herisau, Switzerland produced a major breakthrough to the "time problem" — Rapid DC Polarography. With this method the mercury drops of an otherwise normal dropping capillary are mechanically induced to fall at a much faster rate. Consequently, artificial drop signals measured in tenths of seconds are obtained. Since a considerably greater number of individual drops are utilized, one can also increase the speed of the potential change. The normal running time in Rapid Polarography is 50 seconds. With a drop interval of 0.2 seconds there are 250 drops on the polarogram. To obtain the same number of measuring points with the standard method would require a running time in excess of 12 minutes for a drop interval of 3.0 seconds.

SEND FOR COMPLETE DESCRIPTIVE CATALOG TH 25



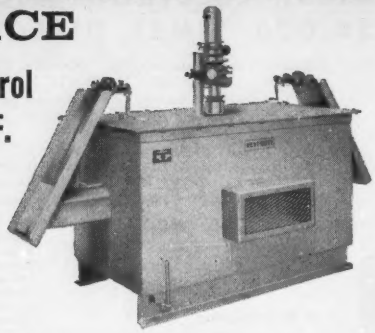
BRINKMANN

C. A. BRINKMANN & CO.

115 CUTTER MILL ROAD, GREAT NECK, N. Y. PHILADELPHIA CLEVELAND HOUSTON MIAMI

HEVI-DUTY MOLYBDENUM TUBE FURNACE

For long life, accurate control at temperatures to 3,000° F.



Maximum Temperature Uniformity

Low thermal conductivity of insulation reduces heat losses and provides uniform temperatures in the heating chamber. Optional purge and water-jacketed chambers allow charge to be preheated and cooled in protective atmosphere.

Protection is Built In

Special reactor transformer control system guards against overloading the molybdenum heating elements — supplies minimum initial voltage to cold elements — increases voltage as heat and resistance increase.

Easy to Operate, Simple to Service

Furnace may have either an automatic indicating and controlling pyrometer or manual controls and optical sighting window. Either system will give accurate temperature control. Top of furnace is removable for easy access to elements.

HEVI-DUTY

Get full details on this high-temperature laboratory furnace in Bulletin 758.

A DIVISION OF BPC BASIC PRODUCTS CORPORATION

HEVI-DUTY ELECTRIC COMPANY, MILWAUKEE 1, WISCONSIN

Industrial Furnaces and Ovens, Electric and Fuel • Laboratory Furnaces • Dry Type Transformers • Constant Current Regulators

HERE'S A QUALITY STUDENT MICROSCOPE AT A BUDGET PRICE!

Although budget priced, the UNITRON Model MUS is definitely not just another student microscope. It includes these significant features often lacking in much more costly student models:

- NOT JUST a disk diaphragm . . . but an iris diaphragm for perfect control of aperture.
- NOT JUST a single focusing control . . . but both coarse and fine.
- NOT JUST a mirror . . . but a condenser for optimum illumination and resolution.
- NOT JUST one objective . . . but three: 5X, 10X, 40X.
- NOT JUST one eyepiece . . . but a choice of two from 5X, 10X, 15X.

Durable, sturdy — ideally suited to withstand the use and abuse of classroom and laboratory.

10 UNITS $66.60 F. O. B. Destination

ASK FOR A FREE 10 DAY TRIAL

Quantity discounts start at 2 — only $65.12 for 11 — 24 units

UNITRON

INSTRUMENT DIVISION of UNITED SCIENTIFIC CO.
204-206 MILK STREET • BOSTON 9, MASS.

Please rush UNITRON's Microscope Catalog 4-E-2

Name_____

Company_____

Address_____

City_____ State_____

EPIDEMIOLOGY OF MENTAL DISORDER

AAAS Symposium Volume No. 60

Edited by Benjamin Pasamanick

A symposium organized by the American Psychiatric Association to commemorate the centennial of the birth of Emil Kraepelin; cosponsored by the American Public Health Association.

. . . pioneering interdisciplinary studies by investigators from biostatistics, genetics, obstetrics, pediatrics, psychiatry, psychology, public health and sociology.

December 1959, 306 pp., $6.50
AAAS members' cash orders, $5.75

English Agents: Bailey Bros. & Swinfen, Ltd.
West Central Street
London W.C.1, England

American Association for the Advancement of Science

1515 Massachusetts Ave., NW
Washington 5, D.C.

Letters

(Continued from page 110)

not the case here, one must conclude that "unnecessary" errors were made.

The "unpublished" sources Steward mentions did not concern the errors but concerned cultural materials for which some form of publication existed in, or before, 1957, except for my Yaruro materials (Steward did indeed suggest investigating this interesting group, and I have not forgotten this). Some sources appear to me, despite the authors' belief that South American interpretations "will not be greatly affected by current research" (p. vi), to be changing current views. Thus, Moore [thesis, Columbia University (1957); *Dissertation Abstr.* **17** (Apr. 1957); Columbia Univ. Press, (1958)] and Murra [thesis, University of Chicago (1956); *Dissertation Abstr.* **16**, 90 (1956)] have modified our conception of the Inca's state and economy and hence, perhaps, of their evolutionary status. Similarly, Wilbert's comment and Le Besnerais' material further confirm Hohenthal's exclusion of northern South American "marginals" from the "Marginal" category [thesis, University of California, Berkeley (1951), abstracted in *Kroeber Anthropol. Soc. Papers* **16** (1957)], a category the authors largely retain (chaps. 13 and 14, especially pp. 374, 454). The authors, by their own use of still unpublished Warrau data, confirm the importance of such material, since they sharply modify previous treatments [for example, *Handbook* (1948), vol. 3, pp. 869–881; Steward and Faron, *Native Peoples of South America* (1959), p. 245], creating still unsolved classificatory problems requiring speculation (p. 443).

ANTHONY LEEDS
City College, New York

Food Additives

In a recent issue of *Science* [131, 979 (1 Apr. 1960)], William J. Darby made comment about my recent book, *The Poisons in Your Food*. His remarks went far beyond the accepted bounds of a review.

I understand that it usually takes several months before a book is reviewed in *Science*. In this case, however, Darby's attack appeared only one month after my book was published by Simon and Schuster. The timing was especially fortunate for those who favor the wholesale addition of chemicals to foods. Only a few days after Darby's "review" appeared, the Manufacturing Chemists' Association was able to send reprints of it to newspaper editors

throughout the country. It is also being sent to librarians throughout the country.

Darby, unfortunately, dodged the real problem by carefully avoiding the documented facts in the book, concentrating instead on character assassination and diatribe. This was hardly the treatment one would expect from a top scientist who was assigned to review a book obviously considered worthy of his talents. It was also extraordinary that the book was assigned to the chairman of a group that has enthusiastically supported the use of chemicals in foods, and that has not been divorced from the fortunes of the food and chemicals industries.

Darby charged that "most of the 'authorities' named in the book are the [organic] cult leaders, their gods, or a few true scientists whose work or expressions have been taken either out of context or out of time. . . ." Again, he gave no bill of particulars.

Would he classify as "cult" leaders such men as Malcolm Hargraves of the Mayo Clinic; Arnold J. Lehman, chief pharmacologist of the Food and Drug Administration; David E. Price, assistant surgeon general of the U.S. Public Health Service; Arthur A. Nelson of the Food and Drug Administration; the late Anton J. Carlson of the University of Chicago; David Rutstein, head of the department of preventive medicine, Harvard University; Francis E. Ray, head of the Cancer Research Laboratory, University of Florida; H. M. Sinclair, director of the Laboratory of Human Nutrition, University of Oxford; W. C. Hueper, head of environmental cancer research, National Health Institute—and many others of their caliber?

All of these scientists have warned against various aspects of the food-chemicals problem and are quoted in my book. Could they be accused of "blood-thirsty pen-pushing" and "muck-raking"?

The nature of Darby's "review" becomes apparent when he accuses me of taking "scientific facts" from certain publications which he implies are worthy of contempt. Does he think that merely because a scientific fact is reported in a lay publication such as *Time* (one of the magazines he named) it should be discredited? Readers of the review will note that the publications Darby listed are not cited for scientific content but primarily because of their colorful reactions to various substances used in foods.

In the same vein, Darby charges that the book "is an irresponsible bid for wide sales through sensationalism." This would indicate that he thinks anyone who doesn't agree with him is an opportunist and a scoundrel, and that those who don't share his convictions are incapable of acting in good faith.

For the record, I would like to point out that this book was written a year before it was published. At that time the cranberry and stilbestrol incidents hadn't yet exploded, and there seemed little likelihood of a large sale. I wrote the book without expectation of making money, but out of conviction about the harmful effects of these chemicals after a 3-year study of the problem, and Simon and Schuster made it clear that they were publishing it in the spirit of public service. (Every newspaperman is entitled to be bitten by one cause in his professional career; this was mine.)

In passing, I note that Christian Hamburger, whom Darby derides by innuendo, was only one of many physicians who warned against the dangers of the carcinogen stilbestrol in meat. Among the others are Hueper; Robert K. Enders, chairman of the department of zoology at Swarthmore College and an adviser to the Department of Agriculture and the Department of the Interior; and Carl G. Hartman, director of physiology and pharmacology for Ortho Research Foundation, a branch of Johnson and Johnson.

Could Darby be considered on the side of the consumer when he supports the use of a chemical like stilbestrol that, apart from its biological effects, fattens cattle by making the flesh absorb water?

Darby, of course, completely ignores the central theme of the book—the chronic effect of continued small doses of poison. From his so-called review no one would suspect that this problem exists. But even if he has convinced himself that it does not exist, the Food and Drug Administration still recognizes it and its threat to human beings.

Paul L. Day, scientific director of the Food and Drug Administration, recently stated that there are approximately 1500 chemicals used in foods and that some could be injurious to human beings. "The danger, where it exists, is usually not one of acute toxicity . . . but long-term toxicity, far more subtle and therefore more to be feared," he stated. "DDT, for example, causes no obvious symptoms when ingested in small amounts, but may collect in the liver and do irreversible damage."

Nor is it possible to discount the warning of Hueper that "it is . . . a well established fact that an appreciable and growing number of chemicals, of which a few are known to enter the human food supply, are capable of causing and do cause cancers in man under proper conditions of exposure."

That is what *The Poisons in Your*

Under the direction of
The American Ceramic Society . . .

a major source of
scientific communication—

GLASS AND CERAMICS

Translated from Russian into English

This Soviet monthly, published for glass and ceramic researchers, technologists and production workers, provides Western scientists with reports on the latest technical advances from the laboratories and plants of the USSR.

Translation of GLASS AND CERAMICS, prompted by the recognition given to Soviet work in the field, permits you to take advantage of their intensified research program. Using these accurate translations by a staff of bilingual scientists can eliminate costly duplication of research. Scientists in this country can learn the specifics about how their Soviet counterparts upgrade products and improve processes; design unique, improved equipment; break production records and reduce costs.

GLASS AND CERAMICS will be published in the most effective manner possible to bridge the gap since this journal was last available in complete translation.

1956 and 1957 have been published. 1958 and 1959 will be brought out in four-issue volumes on a bimonthly basis until they are completed.

Subscription prices: $80.00 per year.

Foreign: $85.00 per year.

Also available in English:

1. 1st Conference on the Structure of Glass (held in Leningrad), 296 pp., profusely illustrated . . . $20.00.

2. Proceedings of 2nd Conference on Structure of Glass, to be published soon . . . $20.00.

Detailed tables of contents will be sent upon request.

Order on approval from:

CONSULTANTS BUREAU ENTERPRISES, INC.

227 W. 17th St., New York 11, N.Y.

Food is about. I ask the reader only to examine the evidence and make up his own mind about where the truth lies.

If, as Darby implies, the problem of poisons in foods doesn't exist, perhaps he could answer these questions: Why did the American Meat Institute recently ask Congress for $15 million for government research to find chemicals whose residues in meat would be less toxic. Why has President Eisenhower demanded a review of the entire food-chemicals subject? Why has Representative King of Utah introduced legislation to establish a committee to learn the effects of food chemicals on consumers? Why has Secretary Flemming been ordered to move behind the scenes to avoid any more cranberry or stilbestrol incidents that cause the public to ask embarrassing questions? Why is the Food and Drug Administration so disturbed about pesticide and antibiotic residues in milk?

I defy anyone of sound mind and good conscience to study the voluminous tables of permissible pesticide residues on fruits, vegetables, and meat and then say that a poison-in-foods problem does not exist.

Darby must know that there is a problem and that it is a serious one. It will not be solved, nor will it cease to exist, through being ignored or through attempts to smear and discredit those who attempt to inform the public about the risk it is being subjected to. The problem is only intensified and people become disenchanted when men of influence try to suppress and distort the truth.

WILLIAM F. LONGGOOD
New York, New York

I appreciate the opportunity to comment on Longgood's letter in which he discusses my recent review of his book, *The Poisons in Your Food*. In order to determine whether my "remarks went far beyond the accepted bounds of a review," and to judge Longgood's concern for the recency of the review, I took the occasion to refer to the second edition (1957) of Webster's *New International Dictionary of the English Language*, published by the C. C. Merriam Company. This defines a book review as "a critical account of a book, usually a recent book." I believe the review to which Longgood takes exception fits the definition.

WILLIAM J. DARBY
School of Medicine, Vanderbilt University, Nashville, Tennessee

It is by no means unusual for Science *to review a book within a month of its publication. Occasionally, in fact, we obtain galley proofs of a book and publish a review at the same time the book is published.*—ED.

Meetings

Preserving Our Science Archives

An important conference on science manuscripts was recently held at the Powell auditorium of the Cosmos Club in Washington, D.C. This 2-day general discussion was made possible by a grant from the National Science Foundation to the History of Science Society. The organizing committee was under the chairmanship of Nathan Reingold of the Library of Congress and included Herman R. Friis of the Society of American Archivists; Philip M. Hamer, National Historical Publications Commission; Robert P. Multhauf, Smithsonian Institution; and André C. Simonpietri, National Research Council. With this broad backing, the growing problem of handling scientific archives is receiving needed attention.

In order to understand adequately the main factor, science, in our current culture, it is necessary that there be appropriate preservation, cataloging, analyzing, and reviewing of original documentary material in all of the sciences. It is becoming more important all the time to learn how our scientific ideas are generated, transmitted, tested, and applied. This information is by no means fully available in formal scientific communications. It is to be found in laboratory daybooks; in personal, organizational, and editorial correspondence; and in notebooks, manuscript drafts, organization reports, personal memoirs and diaries, records of interviews, autobiographical notes, sound recordings, pictures, and movies. This great mine of scientific information is often totally neglected. The material is either cleared out by impatient secretaries or administrators, thrown away by unthinking relatives, or destroyed deliberately by overmodest, disillusioned, or frustrated scientists themselves or, sometimes, by jealous pupils or successors.

Of course, much of this scientific documentary material is not worth saving. The pertinent question—What shall we save in our scientific archives?—was well explored by a panel at the conference. This group included A. Hunter Dupree, University of California (Berkeley); Harry Alpert, University of Oregon; Kendall Birr, State University of New York; Hugh Odishaw, U.S. National Committee for the IGY; Ralph Gabriel, American University; Nathan Reingold, Library of Congress; and Luther Evans, Brookings Institution. In the discussion it was emphasized that selection of material for preservation, for comment, or for publication may contribute to myth-making or orthodoxy but is necessary to avoid being overwhelmed by bulk.

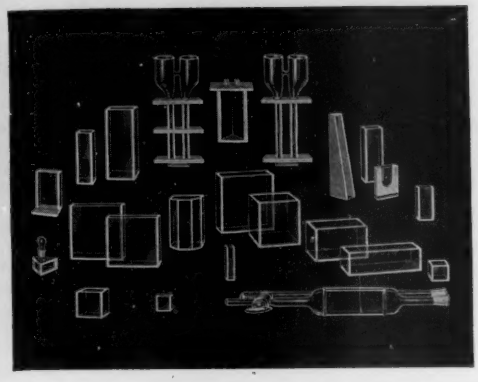
All of the speakers stressed the importance of the informal records of scientists and the need to educate both scientists and university librarians and archivists about the desirability of systematically preserving such records.

The historian and archivist of science must be a discriminating artist as well as a sound judge of what is scientifically significant. The role of the archivist in scientific documentation was discussed in a paper by Wayne C. Grover, Archivist of the United States, which was read by Deputy Archivist R. H. Bahmer. The broad scope of the problem of maintaining science archives was indicated by Henry Guerlac of Cornell University, president of the History of Science Society. Richard Shryock, librarian of the American Philosophical Society, showed the value of such archives for historical as well as scientific purposes.

Case studies of research experience in science achives were reported by Whitfield Bell, associate editor of *The Papers of Benjamin Franklin*; by Richard Hewlett, historian of the Atomic Energy Commission; and by Saul Benison of Columbia University. Donald Fleming of Harvard (in a paper read by Henry Guerlac), Karl F. Heumann of the National Research Council, and Oliver W. Holmes of the National Archives discussed proposed research in the problems of science archives and the possible solutions. Bentley Glass of Johns Hopkins University commented on the difficult matter of stimulating individual scientists to take responsibility for the management of their own scientific records and correspondence.

Every scientist has an obligation, as a member of society and as a scientist, to keep accurate records of his scientific work. Such records are usually conveniently kept in his laboratory daybooks. The notebooks may also include abstracts of his reference reading or of conversations, reports, or discussions. These records are supplemented by his correspondence files. All these comprise his personal scientific archives. If the laboratory in which he works is properly managed, this unpublished material becomes part of the laboratory library. As it accumulates it is periodically cataloged, analyzed, and reviewed. What is clearly worthless is discarded, but what appears to have continuing interest is kept. Gradually, what becomes historically significant may be transferred to the library of the institution concerned, whether university, agency, or commercial concern. Some of it may find its way to state historical societies. Wherever it may be deposited, it should be listed in the National Union Catalog of Manuscript Collections, which is being assembled by the Library of Congress. These scientific records may become the basis, like hospital records, for significant case histories, or, if analyzed and reviewed, for statistical treatment in

GLASS ABSORPTION CELLS made by KLETT



SCIENTIFIC APPARATUS

Klett-Summerson Photoelectric Colorimeters—Colorimeters — Nephelometers — Fluorimeters—Bio-Colorimeters — Comparators — Glass Standards—Klett Reagents.

Klett Manufacturing Co.

179 East 87 Street, New York, New York

FOLIA BIOLOGICA (PRAHA)

Folia biologica, which is a journal of the Czechoslovak Academy of Sciences, publishes articles related to experimental zoology and medicine and in particular to the study of developmental mechanisms in ontogenesis, which are usually considered as belonging to the sphere of cytology, embryology, genetics, immunology, radiobiology and oncology. Folia biologica thus attempts to unite subject matter which, in given developmental stages of biology, is usually divided among different specialized branches of biology. From the developmental aspect, however, these all form part of basic general biological problems, including problems of genetic determination, differentiation and morphogenesis, both from the aspect of mechanisms at molecular and cellular level and from the aspects of the functions of the organism as a whole, such as problems of regeneration, transplantation and reproduction.

Editorial Board

F. Burian (Prague), P. M. Chepov (Moskow), A. Graffi (Berlin), M. Hašek (Prague), A. I. Hadjioloff (Sofia), F. Herčík (Brno), A. Lengerová (Prague), I. N. Maisky (Moskow), I. Málek (Prague, Chief Editor), B. Menkes (Timisoara), J. Riman (Prague), M. Skalka (Brno), S. Skowron (Cracow), F. Sládeček (Prague), V. Thurzo (Bratislava), I. Törö (Budapest), M. Vojtíšková (Prague, Editorial Secretary), K. Wenig (Prague), L. A. Zilber (Moscow).

Folia biologica appears bi-monthly with 80 pp. and 8 plates, size L.8°. Annual subscription $6.30

Subscriptions, inquiries address to your local newsagent or directly to ARTIA, Praha, Czechoslovakia.

Sigma is Pleased to Announce the Beginning of work on new High-Purity Reagents for

HISTOCHEMISTRY

We have much to learn about this tremendously large field. With *your* help, we can ultimately be of considerable assistance to *you*. Let us know what you need. We probably won't be able to deliver it immediately (if not already in stock), but we will certainly try to prepare it when we can.

ALREADY AVAILABLE:—

Carbobenzoxy Chloride
5-Bromoindoxyl Acetate
Indoxyl Acetate
DL-Alanyl-β-Naphthylamide
L-Leucyl-β-Naphthylamide
Red Violet LB Salt
Fast Garnet GBC Salt
Naphthol AS-BI Phosphate
5-Bromo-6-Chloroindoxyl Acetate
5-Bromo-4-Chloroindoxyl Acetate
o-Benzyl-DL-Serine
N-Chloroacetyl-DL-Phenylalanine
N-Carbobenzoxy-L-Alanine
N-Carbobenzoxy-S-Benzyl-L-Cysteine
N-Carbobenzoxy Glycine
N-Carbobenzoxy-L-Methionine
N-Carbobenzoxy-L-Proline
N-Carbobenzoxy-DL-Serine

Others will be added regularly. Write for our list.

Sigma is the unquestioned leader in the production of *highest purity* Nucleotides offered at the *World's Lowest Prices!*

β-DPN TPN β-DPNH TPNH
Adenosine, Cytidine, Guanosine, Uridine Phosphates.

Deoxy Adenosine, Cytidine, Guanosine, & Thymidine Mono-, Di-, and Triphosphates.

UDP Glucose
UDP Glucuronic Acid
UDP Acetyl Glucosamine
ADP Ribose
CDP Ethanolamine
GDP Mannose
Nicotinamide Mononucleotide
Ribose-5'-Phosphate Sodium

CALL US COLLECT, JUST TO GET ACQUAINTED

Day, Station to Station, PRospect 1-5750
Night, Person to Person, Dan Broida, WYdown 3-6418

The Research Laboratories of

SIGMA
CHEMICAL COMPANY

3500 DEKALB ST., ST. LOUIS 18, MO., U. S. A.

estimating trends, procedures, thinking habits, biases, or ingenuity of various scientific groups.

The Conference on Science Manuscripts will try to arrange for some continuing effort to manage our rapidly growing science archives. It may seek the cooperation of the History of Science Society, the American Association for the History of Medicine, the Society of American Archivists, and other interested organizations in holding annual meetings. American scientists are now being reminded of their responsibility to keep in good order their individual scientific records and correspondence. Such record-keeping, in itself, may give the scientist a better understanding of the genesis and growth of his scientific ideas and of the psychological factors involved in reaching those agreements on scientific conclusions which constitute their validity.

CHAUNCEY D. LEAKE
Ohio State University, Columbus

Forthcoming Events

August

14–19. American Pharmaceutical Assoc., Washington, D.C. (R. P. Fischelis, APA, 2215 Constitution Ave., NW, Washington 7)

14–19. International Cong. of Clinical Chemistry, Edinburgh, Scotland. (S. C. Frazer, Clinical Laboratory, Royal Infirmary, Edinburgh)

14–20. Cardiology, 6th Inter-American cong., Rio de Janeiro, Brazil. (H. Alqueres, P.O. Box 1594, Rio de Janeiro)

15–16. National Assoc. of Boards of Pharmacy, Washington, D.C. (P. H. Costello, 77 W. Washington St., Chicago, Ill.)

15–17. Heat Transfer Conf., ASME and AICE, Buffalo, N.Y. (A. B. Conlin, Jr., ASME, 29 W. 39 St., New York 18)

15–17. Organic Scintillation Detectors, intern. conf., Albuquerque, N.M. (G. H. Daub, Chemistry Dept., Univ. of New Mexico, Albuquerque)

15–18. American Veterinary Medicine Assoc., Denver, Colo. (H. E. Kingman, Jr., 600 S. Michigan Ave., Chicago 5)

15–18. Radiation Biology, 3rd Australian conf., Sydney, Australia. (P. Ilbery, Dept. of Preventive Medicine, Univ. of Sydney, New South Wales, Australia)

15–20. International Astronautical Federation, 11th cong., Stockholm, Sweden. (Secretariat, Intern. Astronautical Federation, 12, Bessborough Gardens, London, S.W.1, England)

15–23. Soil Science, 7th intern. cong., Madison, Wis. (R. Bradfield, Dept. of Agronomy, Cornell Univ., Ithaca, N.Y.)

15–24. Crystallography, intern. cong., Cambridge, England. (W. H. Taylor, Cavendish Laboratory, Cambridge, England)

15–25. Chemistry of Natural Products, IUPAC symp., Melbourne, Canberra, and Sydney, Australia. (Convener, Symposium Organizing Committee, Box 4331, G.P.O., Melbourne)

15–25. International Geological Cong., 21st session, Copenhagen, Denmark. (IGC, Mineralogical-Geological Museum, Univ. of Copenhagen, Øster Boldgade 7, Copenhagen K)

15–25. International Paleontological Union, Copenhagen, Denmark. (J. Roger, Service d'Information Geologique, B.R.G.-G.M., 74, rue de la Fédération, Paris 15e, France)

15–25. Sedimentology Cong., 6th intern., Copenhagen, Denmark. [General Secretary, IAS, c/o Institut Français du Petrole, 4, place Bir Hacheim, Rueil-Malmaison (Seine-et-Oise), France]

16–18. Biological Effects of Microwave Radiation, 4th annual conf., New York, N.Y. (M. Eisenbud, New York Univ. Post Graduate Medical School, 550 First Ave., New York 16)

16–19. Society of Automotive Engineers, San Francisco, Calif. (R. W. Crory, SAE, Meetings Operation Dept., 485 Lexington Ave., New York 17)

17–19. Hydraulics Conf., Seattle, Wash. (W. H. Wisely, American Soc. of Civil Engineers, 33 W. 39 St., New York 18)

17–19. University Nuclear Reactors, Gatlinburg, Tenn. (University Relations Div., Oak Ridge Inst. of Nuclear Studies, P.O. Box 117, Oak Ridge, Tenn.)

17–21. Ionization Phenomena in Gases, 4th intern. conf., Uppsala and Stockholm, Sweden. (A. Nilsson, Fysikum, Uppsala)

(See issue of 17 June for comprehensive list)

MULTIPLE-REFLECTION
GALVANOMETER
FOR LABORATORY AND PLANT

A self-contained spotlight galvanometer of extreme sensitivity for the indication of minute D. C. currents and voltages.

model 45

- Bright light spot, sharp hairline index, tilted scale
- Scales for null indication and deflection readings
- Single knob wide-range zero-adjustment
- All metal construction, dust-protected, shock-mounted

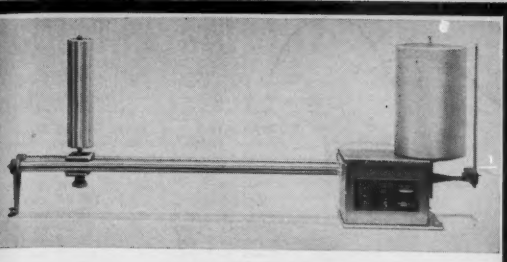
Write for descriptive Bulletin #965 to
PHOTOVOLT CORP.
95 MADISON AVENUE • NEW YORK 16, N. Y.
Also: Colorimeters, Fluorescence Meters, Recorders, pH Meters

NEW!
low to high voltage DC to DC
CONVERTER
transistorized with 45 watt output

This remarkable new high voltage source and battery eliminator weighs only 3½ lbs. . . . provides complete isolation from power line. It's instant starting, quiet, creates no electrical interference and contains no moving parts, tubes or vibrators. From 6 or 12 volt DC source it provides 225 or 450 volt output at currents up to 100 ma. In attractive blue and gray case. Write for literature.

Cenco No. 79570.....each $99.50

cenco®
CENTRAL SCIENTIFIC CO.
A Subsidiary of Cenco Instruments Corporation
• 1718-M Irving Park Road • Chicago 13, Ill.
Branches and Warehouses—Mountainside, N. J.
Boston • Birmingham • Santa Clara • Los Angeles • Tulsa
Houston • Toronto • Montreal • Vancouver • Ottawa



Bird-Walton **KYMOGRAPH**

Five gear shifts and variable transformer offer speed ranges of nine thousand to one!

Approximate maximum speed, 400 cm a minute, minimum .045 cm. a minute. Drum, 64 cm. cir., 30.5 cm. high. Belt lengths to app. 275 cm. may be used.

One support arm included with kymograph.

CAT. No. 70-102

PHIPPS & BIRD, INC.
Manufacturers & Distributors of Scientific Equipment
6th & Byrd Streets - Richmond, Va.

new england nuclear

NEC-193

D-Glucosamine-1-C^{14} Hydrochloride

$60 per 100 microcuries

CATALOG ON REQUEST

new england nuclear corp.

575 ALBANY STREET, BOSTON 18, MASS. Liberty 2-5964

PERSONNEL PLACEMENT

CLASSIFIED: Positions Wanted, 25¢ per word, minimum charge $4. Use of Box Number counts as 10 additional words. Payment in advance is required. **Positions Open,** $40 per inch or fraction thereof. No charge for box number.

COPY for classified ads must reach SCIENCE 2 weeks before date of issue (Friday of every week).

DISPLAY: Rates listed below—no charge for Box Number. Weekly invoices will be sent on a charge account basis—provided that satisfactory credit is established.

Single insertion	$40.00 per inch
4 times in 1 year	38.00 per inch
7 times in 1 year	36.00 per inch
13 times in 1 year	34.00 per inch
26 times in 1 year	34.00 per inch
52 times in 1 year	32.00 per inch

For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

Replies to blind ads should be addressed as follows:
Box (give number)
Science
1515 Massachusetts Ave., NW
Washington 5, D.C.

POSITIONS WANTED

Bacterial Physiologist, M.S., age 33. Experienced radiotracers, ion-exchange, paper chromatography, enzyme techniques. Strong biochemistry, general bacteriology. Box 153, SCIENCE. X

Bacteriologist, Virologist, M.S., 5 years of academic research, knowledge tissue culture, desires research position. East. Box 150, SCIENCE. X

Physiologist-Pharmacologist; 13 years of experience teaching and pharmaceutical industry. Desires teaching position only anywhere except South. Married, 4 children. Available almost immediately. Box 146, SCIENCE 7/15, 22

POSITIONS OPEN

Biochemist, Ph.D., 35. Nutrition, clinical chemistry experience. Desires relocation, research possibilities. Prefers university city. Bilingual, English-Spanish. Box 151, SCIENCE. 7/29

Medical Writing (also rewriting), editing, medical literature research, abstracting. Highest references. Box 152, SCIENCE. X

Virologist, M.D., 9 years of postgraduate experience, academic and industrial virus and cancer research, experienced in virus isolation, classification, vaccine development, all phases of tissue culture, administrative experience, publications, patents. Desires responsible academic or industrial position. Box 154, SCIENCE. X

Virologist, August Ph.D. Desires research or teaching position. Box 145, SCIENCE. 7/15

POSITIONS OPEN

ATOMIC PERSONNEL, INC.

WRITE FOR APPLICATION OR SEND RESUME

•

Confidential Handling

A NATIONAL EMPLOYMENT AGENCY for the *NUCLEAR FIELD*

•

NO CHARGE TO INDIVIDUALS

Suite 1207-0, 1518 Walnut St., Phila. 2, Pa.

Applications are invited for a position in the **Department of Bacteriology** as **Assistant Professor,** salary range $6000 to $8000 depending on qualifications and experience. Duties will include formal lecturing and instruction at all levels in microbiology. Qualifications: Ph.D. in microbiology preferably with major in bacterial physiology and biochemistry. Applications should be addressed to the Department of Bacteriology, University of Alberta, Edmonton, Alberta, Canada, and should include personal data, transcripts of record, a recent photograph or snapshot, and the names of three referees. X

POSITIONS OPEN

BACTERIOLIGIST. $9138 annually. Ph.D., U.S. citizenship required. Principal functions: control of methods, teaching and consultation to staff, clinical research. New 500-bed hospital and large laboratory nearing completion, near University of Michigan and Wayne State University. Pension, life insurance and hospitalization plans, social security, liberal vacation, sick leave. For application write Wayne County Civil Service Commission, 628 City-County Building, Detroit 26, Mich. 7/15, 22

(a) **Biology Instructor;** young Ph.D. to teach physiology, anatomy to graduate students, student nurses; strong science department, midwestern liberal arts college; large capital city. (b) **Biochemist,** Ph.D. to supervise cardiac laboratory, university medical school, affiliated hospital; train technicians, set up new tests; to $9000, faculty appointment if desired; Mideast. (c) **Bacteriologist;** B.S., experienced for active clinical laboratory, 250-bed general hospital; to $5400; college city 150,000; Southwest. (d) **Microbiologist** B.S., M.S., for research, some teaching; eastern university medical school; opportunity for graduate study if desired. (e) **Biochemist;** Ph.D. to supervise department, develop new tests, some teaching, research of own choosing; fully approved 400-bed general hospital; midwestern university city 125,000. (Please write for an analysis form. Our 64th year: founders of the counselling service to the medical profession: serving medicine with distinction over half a century.) Science Division, Woodward Medical Bureau, Ann Woodward, Director, 185 North Wabash, Chicago. X

Chemist. $9138, Ph.D., U.S. citizenship, training and/or experience in pharmacology, physiological or toxicological chemistry. Position available in modern well-equipped toxicology laboratory in County Medical Examiner's Department, downtown Detroit. Liberal fringe benefits. Close to Wayne State University College of Medicine. For application write Wayne County Civil Service Commission, 628 City-County Building, Detroit 26, Mich. 7/15, 22

POSITIONS OPEN

BACTERIOLOGISTS
BIOLOGISTS
MEDICAL TECHNOLOGISTS

Parke, Davis & Company has a number of openings in the Detroit area for female bacteriologists, biologists, and medical technologists at the B.S. and M.S. level, to do laboratory work in our research and production facilities. These openings are in virology, bacteriology, biology, antibiotics, immunology, and microbiological assay. Excellent opportunities to advance. Send complete résumé to

Personnel Department
Parke, Davis & Company
Detroit 32, Mich.

BIOCHEMIST

Ph.D to conduct fundamental research in enzymology of the skin. The independent nature of the problem requires initiative, imagination and a good research background. Fully equipped, modern laboratory centrally located in Chicago. Full employee benefits.

Send complete résumé and salary requirements in confidence to:

J. P. Hamilton
THE TONI CO.
A Division of Gillette
456 Merchandise Mart
Chicago 54, Illinois

BIOLOGICAL SCIENTIST

Well-known pharmaceutical manufacturer located in Philadelphia has several openings for alert individuals having M.S. or B.S. in the preclinical sciences. Position in Science Information Department offers opportunities to work with a wide variety of scientific subjects. Applicants should have good written and oral expression. Liberal benefits. Send complete resume. Box 155, SCIENCE.

Graduate Assistantship. Rabbit genetics breeding program. Work applicable to biology M.S.,–2- to 3-year tenure. Contact Jack Bennett, Northern Illinois University, DeKalb, Illinois. 7/29

IMMUNOCHEMIST M.D. or PhD.
with training in immunochemistry or immunology. Individual must be capable of carrying out independent basic research studies on properties of the red cell. Some supervisory experience preferred. Send résumé to Employment Manager.
ORTHO PHARMACEUTICAL CORPORATION
ROUTE 202, RARITAN, N. J.

LITERATURE CHEMIST

Permanent opening for person with degree in chemistry (organic background). Must be able to prepare translations from German, Russian, and French. Knowledge of Italian and Swedish desirable, but not essential. Under the guidance of the editor of the *Merck Index* selects material; collects data on new drugs and chemicals; assists in writing new monographs; handles correspondence with users of the *Index*; studies the literature of chemical nomenclature, reports changes and advances to the editor; and makes comprehensive literature searches. Salary commensurate with qualifications and experience. Send detailed résumé to

Personnel Manager
Merck Sharp & Dohme Research Laboratories
Rahway, New Jersey

Pharmacologist. B.S. or M.S. with 2 to 6 years' experience in drug evaluation, or recent Ph.D., for research department of rapidly expanding upstate New York pharmaceutical company. Box 144, SCIENCE. 7/15

POSITIONS OPEN

Pharmaceutical or Organic Chemist for research and development of new drugs in the medicinal and animal health fields. Ph.D. or equivalent experience. Profit-sharing program, benefits, and opportunities with rapidly expanding midwestern pharmaceutical company. Send résumé and salary requirements in confidence to Director of Research, Diamond Laboratories, 2538 S.E. 43rd Street, Des Moines, Iowa. X

RADIOCHEMIST

for organization Radiochemistry Department associated with 3 megawatt Reactor for research and limited production of radioactive isotopes. Research experience and previous publications indispensable. Knowledge of Spanish desirable or willingness to learn the language.

Send detailed curriculum vitae and reprints to

Dr. Marcel Roche, Director
Instituto Venezolano de Investigaciones Cientificas
Apartado 1827
Caracas, Venezuela

SPECIAL LIBRARIAN

M.L.S., or equivalent, to head industrial library devoted to medical, chemical, biological literature. Previous special library experience desirable. Salary up to $485 depending on qualifications. Write to Director of Research

Cutter Laboratories
4th and Parker Street
Berkeley, Calif.

TREE PHYSIOLOGIST
required by
Department of Northern Affairs and National Resources
VICTORIA, BRITISH COLUMBIA
$6,840 - $7,860

Challenging opportunity to plan and undertake a Research Program in Tree Physiology relating particularly to Douglas Fir in British Columbia.

For complete details and application form, write to

CIVIL SERVICE COMMISSION OF CANADA
OTTAWA, ONTARIO

And ask for Information Circular 60-1453.

Positions Open

Effective 1 September 1960

Rates net—No agency commission

No cash discount

Minimum ad: 1 inch. Ads over 1 inch will be billed to the nearest quarter inch.

Frequency rate will apply only to repeat of same ad. No copy changes.

The Market Place

BOOKS • SERVICES • SUPPLIES • EQUIPMENT

DISPLAY: Insertions must be at least 1 inch in depth. Weekly invoices will be sent on a charge account basis—provided that satisfactory credit is established.

Single insertion	$40.00 per inch
4 times in 1 year	38.00 per inch
7 times in 1 year	36.00 per inch
13 times in 1 year	34.00 per inch
26 times in 1 year	34.00 per inch
52 times in 1 year	32.00 per inch

For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

BOOKS AND MAGAZINES

Your sets and files of scientific journals

are needed by our library and institutional customers. Please send us lists and description of periodical files you are willing to sell at high market prices. Write Dept. A3S, CANNER'S, Inc. Boston 20, Massachusetts

SCIENTIFIC JOURNALS WANTED

Sets, Runs and Volumes bought at top prices. Your wants supplied from our Back Files of over 3,000,000 periodicals. **Abrahams Magazine Service, N. Y. 3, N. Y.**

SUPPLIES AND EQUIPMENT

CAESAREAN-DERIVED Mice
CHARLES RIVER CD-1
Hypophysectomies
THE CHARLES RIVER MOUSE FARMS
Affiliate, The Charles River Breeding Labs
1018 Beacon St., Brookline 46, Mass. RE 4-2000

YOU NEED THIS FREE CATALOG FOR YOUR FILES

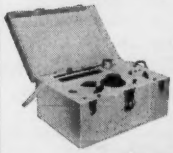
Serums, antiserums and bloods of all kinds for technicians and tissue culture laboratories. No salesman will call.

COLORADO SERUM CO.
4950 York St. • MAin 3-5373 • Denver 16, Colo.

Laboratory Animals

Mice Hamsters Guinea Pigs
Rats Rabbits

Information sent on request
H. S. HURLBURT
Animal Research Center, Bainbridge, N.Y.
WOrth 7-5415



THE JUNIOR Garceau
Electroencephalograph
Price $575.00 complete
No Batteries
Requires no Shielding
Prompt Delivery
A.C. Operated
Inkless Writing
Shipped Ready to Run

ELECTRO-MEDICAL LABORATORY, INC.
South Woodstock 2, Vermont

SWISS MICE

BACTERIOLOGICAL AND GROSS TISSUE STUDY TECHNIQUES USED IN OUR QUALITY CONTROL

HUNTINGDON FARMS, INC.
2548 NORTH 27th ST. PHILA. 32, PA.

PHOTO BY WILL CONNELL

You'd know them anywhere. Beckman pH electrodes...recognized as the finest... and Beckman's Model G pH Meter...described in the literature as the standard of pH measurement. Beckman pH meters and electrodes are used in thousands of laboratories throughout the world. ⌘ Your laboratory apparatus dealer provides prompt delivery on Beckman pH meters and electrodes, including the newest models. Call him today or write to us for a list of dealers and current pH meter information. Ask for Data File 38-29-01.

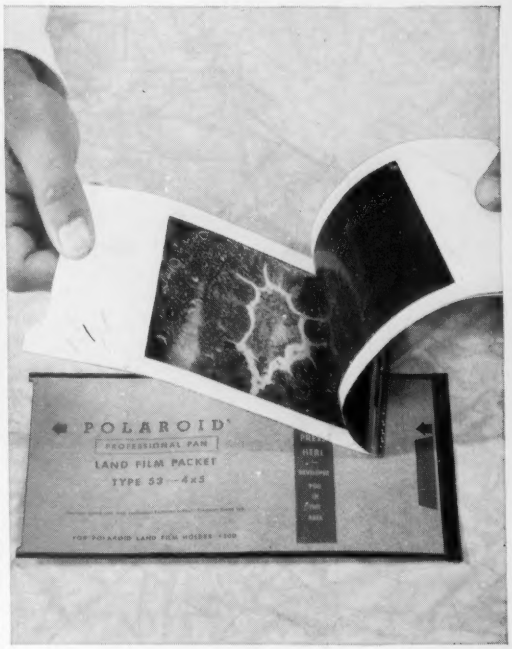
Beckman
Scientific and Process Instruments Division
Beckman Instruments, Inc.
2500 Fullerton Road, Fullerton, California

INSTRUMENTAL IN YOUR FUTURE 25 YEARS 1935-1960

ULTRAVIOLET AND INFRARED SPECTROPHOTOMETERS · GAS CHROMATOGRAPHS · pH METERS · ELECTROCHEMICAL INSTRUMENTS

NOW! Snap it... See it...

IN BIG POLAROID LAND 4" x 5" PRINTS



AO Spencer Photomicrographs
... just 60 seconds from snap to finish

Now your AO Photomicrographic Camera can be equipped with the new Polaroid Land Film Holder to give you big 4"x5" finished, glossy prints ... ready for your files ... in just 60 seconds. A coupled visual and photographic system allows you to shoot exactly what you see ... instantly and effortlessly. Processing of the picture takes place right in Polaroid's 4"x5" Holder, thus possible errors in exposure, illumination or focus can be rectified immediately.

If you prefer, you have a wide choice of 5 other readily interchangeable camera backs; the Polaroid Land Camera Back for roll film, paper prints and transparencies, 4" x 5" fixed back, 4" x 5" Graflok back, 35mm back and Bantam (roll film) back. You choose the camera back and film best suited to your specific requirements.

This new "Big-Size" 4" x 5" Polaroid Film Holder is available from your industrial photographic supplier.

Here, the No. 682G Camera being used with the AO Spencer Series 4 Microstar proves an ideal combination. The built-in base illuminator provides convenient Koehler-type illumination. You select specimen area and do all preliminary focusing through binocular portion of trinocular body ... focus critically with the telescopic eyepiece.

The sturdy vertical pillar, the easily adjustable camera support, the camera back and the Microstar all combine to provide a compact unit in precise, rigid alignment. Successful photomicrography becomes a "snap".

Try it and see for yourself. Your AO Representative will be happy to arrange a convincing demonstration for you.

SPENCER

American Optical Company

INSTRUMENT DIVISION, BUFFALO 15, NEW YORK

Dept. G-3

☐ Please send me Brochure SB682 describing the entire line of AO Spencer Photomicrographic Cameras.

☐ Please send me Brochure SB124 describing the new Microstar line.

Name _____

Address _____

City _____ Zone ____ State ____